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NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

28859 (EOS-150-FINAL) INVESTIGATION OF IONIZED GASES AND ACCELERATION SYSTEMS FOR ION PROPULSION. Final Report, Covering Period, April 1, 1958 to July 1, 1960. (Electro-Optical Systems, Inc., Pasadena, Calif.). July 20, 1960. Contract DA-04-495-ORD-1191. 437p.

A summary is presented of the major accomplishments achieved in implementing a basic design for a practical ion engine. The most striking line of developments may be considered the evolution of motor structures from simple planar diodes to engine prototypes. The evolution of the circular-aperture structures over the linear engines showed that the former have advantages not only in fabrication but also in ease of alignment, ready extrapolation to larger sizes, and higher perveance which more than makes up for the ineffective areas between the holes. The validity of the accelerate-decelerate principle was demonstrated. The results indicate the useful ion motors are multiple-beam devices with high effective aspect ratios. Ionization of cesium on a rhenium surface and on certain semiconducting coatings on tungsten was investigated, and ion production was demonstrated. The importance of charge-exchange processes was analyzed, and while found to be impractical for beam neutralization, they do have considerable effect on accelerator lifetime. A discussion is included of developments in instrumentation for conducting the investigations. (B.O.G.)

28860 (HW-69758) GROUP TESTING IN 100 PER CENT INSPECTION. H. E. Hanthorn and J. L. Jaech (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 1961. Contract AT(45-1)-1350. 24p.

Results are given of a study to determine the optimum testing scheme consisting of drawing a group of optimum size from the population being tested, and retesting it, if required, in subgroups of optimum size. An exact computation of optimum grouping and subgrouping was made. Results are also given to indicate how much loss inefficiency occurs when physical limitations restrict the size of the original group. (J.R.D.)

28861 (IDO-16695) MATERIALS TESTING REACTOR-ENGINEERING TEST REACTOR TECHNICAL BRANCHES QUARTERLY REPORT, JANUARY 1-MARCH 31, 1961. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). June 30, 1961. Contract AT(10-1)-205. 85p.

Large values of reactivity encountered in ETRC measurements of ETR core loadings ($\sim 10\% \Delta k/k$) can be more accurately predicted as a result of the development of a

continuous function equation from distributed poison equations. The behavior of air pulsers for the Idaho Chemical Processing Plant was studied by an improved analog computer which attempts to handle non-linearities in the system. Fuel and boron content were calculated for replacement of ARMF sub-assemblies. Preliminary measurements indicated no serious error from the use of boron in the RMF as a standard of neutron absorption. MUFT-R cross section libraries are now available for some 25 elements. Tubular thorium slug permissible irradiation flux levels were calculated. Calculations were made of the optimum enrichment of spiked thorium samples to be irradiated in testing a breeder concept. In connection with the use of nickel as a fast flux monitor, it was discovered that the 9.1-hr isomer of Co^{58} has a thermal cross section of $\approx 170,000$ b. Irradiated sample fuel plates containing UO_2 dispersed in Al showed good dimensional stability, but revealed reaction zones around fuel particles. Revised estimates show EGCR fuel sample burnup under ETR irradiation to be 30% less than previously estimated; irradiations of remaining samples will be extended to compensate. Total neutron cross section data were determined for Pa^{231} from 0.015 to 2000 ev, for Pa^{241} from 0.02 to 2000 ev, and for a combination of Au^{198} and Au^{199} from 0.01 to 0.4 ev. The scattering cross section of U^{233} from 2 to 20 ev was determined. Investigation of the ratio of asymmetric to symmetric fission of U^{235} as a function of neutron energy was continued. The yield ratios of two isomeric pairs ($\text{Ag}^{110} - \text{Ag}^{110m}$ and $\text{Ir}^{192} - \text{Ir}^{192m}$) formed by neutron activation were determined and the thermal neutron cross sections for activation of iridium isotopes were measured. The energies of two low abundance gamma rays in $40.6\text{-d } \text{Pm}^{148}$ were determined. Data on the inelastic scattering of slow neutrons by methane, Santowax-R, terphenyls, and propane were reduced to curves. Differential scattering cross sections $\sigma(E_0, \epsilon, \theta)$ with respect to energy change ϵ and scattering angle θ were calculated for several incident neutron energies E_0 using the Kreiger-Nelkin approximation. Low frequency vibrations in olefinic hydrocarbons were calculated by treating the CH_2 and CH groups as rigid units capable only of translational and rotational motions. Observation was made of the growth of the Y^{90} ground state activity from the decay of an activity with a half life of ~ 3.14 hr which provides further evidence that the latter activity arises from the decay of an isomeric level in Y^{90} . Branching ratios for α decay of Pu^{239} and Pu^{240} were calculated. A spin of $4+$ was assigned as probable to the 1.57-Mev state in Mo^{94} . Spin and parity assignments were made

for all of the Sm^{148} states excited in the decay of $41\text{-d } \text{Pm}^{148}$. Average cross sections for a fission neutron spectrum were measured for the reaction $\text{K}^{41}(\text{n},\gamma)\text{K}^{42}$ (9.5 ± 0.9 mb), $\text{Na}^{23}(\text{n},\gamma)\text{Na}^{24}$ (0.53 ± 0.05 mb), and $\text{K}^{41}(\text{n},\text{p})\text{Ar}^{41}$ (1.2 ± 0.1 mb). A number of programs for the IBM-650 were completed and placed in the program library for general use. These include a double precision normal equation generator, a predictor-corrector method for differential equations, and a program for the numerical inversion of Laplace transforms. A successful procedure for estimating the optimum overrelaxation constant was added to the steady state temperature program, TDTP. A computer program to automate the design of flat plate fuel elements was written. (auth)

28862 (LA-2549) FORMATION OF UNIFORMLY CHARGED CONDUCTING DROPLETS AND POSSIBLE PROPULSION APPLICATIONS. M. M. Hoffman (Los Alamos Scientific Lab., N. Mex.). Apr. 1961. Contract W-7405-eng-36. 25p.

Experiments were carried out to determine if very small, reproducible droplets of conducting material could be formed in an electrostatic field. The working fluid was introduced into a vacuum chamber containing accelerating and measuring elements. Droplets formed by passing liquid gallium through a capillary tube extending into a high field region were studied by observing the charge and velocity of the droplets after they were accelerated through a known potential drop. It was found that uniform droplets were formed which had a diameter approximately equal to the capillary diameter and which had a charge density of about one-half the maximum theoretical charge density. (auth)

28863 (NASA-TN-D-925) MEASUREMENTS AND CALCULATIONS OF THE EFFECTS OF DISTORTIONS IN THE COLLECTOR SURFACE ON EFFICIENCIES OF UMBRELLA-TYPE SOLAR COLLECTORS. Victor R. Bond (National Aeronautics and Space Administration, Langley Research Center, Langley Field, Va.). Aug. 1961. 44p.

The distortions caused by meridional and transverse tensions in the reflecting surface of an umbrella-type solar collector and the effect of the distortions on the efficiency of the collector are analyzed. Solar collectors of 30, 60, and 90 ribs and with rim angles of 45 and 90° are considered. (auth)

28864 (NP-9499) FIRST ANNUAL REPORT FOR PERIOD ENDING DECEMBER 31, 1957 [OF THE] SOUTH AFRICA ATOMIC ENERGY BOARD. (Union of South Africa. Atomic Energy Board, Pretoria). 59p.

Summaries are presented of the historical activities prior to 1957, membership, finance and accounts, raw materials production and exportation, exploration and extraction activities, and research projects. Appendixes contain listings of the committee of the Board, senior officers of the Board as of Dec. 31, 1957, and financial statements. (B.O.G.)

28865 (NP-9500) SECOND ANNUAL REPORT FOR THE YEAR ENDING DECEMBER 31, 1958 [OF THE] SOUTH AFRICA ATOMIC ENERGY BOARD. (Union of South Africa. Atomic Energy Board, Pretoria). 40p.

28866 (NP-9570) PROGRESS REPORT NO. 18, ON [MICROWAVE RESEARCH] APRIL 1, 1960-SEPTEMBER 15, 1960. Ernst Weber (Brooklyn. Polytechnic Inst. Microwave Research Inst.). Contract AF18(600)-1505. 121p. (R-452.18-60)

Activities are reported for research work in electromagnetics, plasma electrophysics, solid-state physics,

microwave network theory, and systems and controls. (B.O.G.)

28867 (NP-10574) NUCLEAR ENERGY IN YUGOSLAVIA. Slobodan Nakicenovic (Yugoslavia. Nuclear Energy Commission, Belgrade). 1961. 538sp.

The development of nuclear energy in Yugoslavia is reported. Topics covered include economic conditions in the country; the Boris Kidrič Institute at Vincă; the Jožef Stefan Institute; the Rudjer Bošković Institute in Zagreb; present status in the field of basic research; early stages of the nuclear power program; development of isotope applications in agriculture, medicine, and industry; nuclear raw materials survey; Institute for the Technology of Mineral Raw Materials; protection against ionizing radiations; electronics and instrumentation; cooperation with universities; training; scientific meetings in Yugoslavia; cooperation in the international sphere; federal administrative organs in the field of nuclear energy; Nuclear Energy Commission Program for 1961; prospective development; and scientific and technical staff. Nuclear energy legislation and lists of publications resulting from work in Yugoslavia are also given. (M.C.G.)

28868 (NP-10627) EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH, ANNUAL REPORT, 1960. (European Organization for Nuclear Research, Geneva). 113p.

An account is given of CERN's activities during 1960 for organizational changes, theoretical studies, proton synchrotron and synchrocyclotron work, scientific and technical services, site and building construction progress, and administration. (B.O.G.)

28869 (NP-10642) RESEARCH SUMMARY NO. 36-9, VOLUME I FOR THE PERIOD APRIL 1, 1961 TO JUNE 1, 1961 [ON SPACE-RELATED RESEARCH]. (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). July 1, 1961. Contract NASw-6. 104p.

Space instruments evaluations are discussed for electronic circuit elements and tunnel-diode high-speed data automation systems. Systems analyses were made for minimum-energy transfer trajectories to Mars and Jupiter, low-thrust corrections of circular satellite orbits, hyperbolic orbit perturbations; powered-flight terminal-mission performances, and spacecraft performance during flight operations. Spacecraft guidance and control research included studies of adaptive systems, dual-sphere gas-floated gyros, and capillary pumping for closed-cycle gas systems. Mathematical research on the divisibility properties of enumerating functions, inequivalent Hadamard matrices, and the nonexistence of certain perfect sequences is discussed. Communications research investigations are discussed for an FM demodulator with negative feedback, mutually distinguishable self-synchronizing continuous codes, low-noise amplifiers, antennas for space communication, thin-film production techniques, an experimental ranging transponder, and a pseudonoise system lock-in. Chemistry research was conducted for nuclear magnetic spectra of three-proton nuclei, photolysis of ozone, and the use of a proton-proton spin decoupling technique for the determination of NMR chemical shifts. Physics research is reported for vortex tube parameters for gaseous fission reactors, electron exchange correction to phonon dispersion relation in metals, rates of recombination of nitrogen and oxygen atoms, and a plasma theory of the many-electron atom. A gas dynamic study is discussed for laminar boundary layers on a disk in a rotating flow. Engineering and materials research was conducted for the thermal conductivity of MgO, an arc-imaging furnace, thermal degradation of polytetrafluoroethylene *in vacuo*, and plasma

confinement. Engineering facilities developments are discussed for 21-in. hypersonic and low-density wind tunnels. Liquid propellant propulsion studies are described for combustion and injection, and heat transfer and fluid mechanics. Solid propellant propulsion studies are discussed for polymer research and secondary injection for thrust vector control. (B.O.G.)

28870 (NP-10643) REPORT OF VESIAC, COMPENDIUM OF CONTRACT INFORMATION IN THE VELA UNIFORM PROGRAM. Report 4410-8-T. T. W. Caless (Michigan, Univ., Ann Arbor. Vela Seismic Information Analysis Center). Aug. 1961. 134p.

A summary is presented of contract information on the VELA UNIFORM program. The tasks specified are defined, and individual contract details of an informative nature are given. Included are indexes arranged according to research subject headings, names of contracting agencies, and names of governmental and non-governmental individuals responsible for the research. (auth)

28871 (NP-10701) DEPARTMENT FOR REACTOR MATERIALS PROGRESS REPORT FOR PERIOD ENDING DECEMBER 1960. B. Tell, ed. (Aktiebolaget Atomenergi, Stockholm). June 1961. 12p. (R-28)

Fuel Elements. Activities are discussed for design, development, production, and control studies in the fabrication of ceramic and metallic fuel elements, and fuel-element canning materials. **Metallurgy.** Outlines are included of work done in: metallography and metal physics; physics; materials testing and control; pressure-vessel steels; corrosion of aluminum and Zircaloy; and the installation and maintenance of instruments. **Active Metallurgy.** Activities are summarized in terms of work in progress on studies of plutonium metallurgy, irradiation behavior of fuel materials, radiation effects on construction materials, magnetic properties of binary systems, and the installation and maintenance of equipment for handling radioactive materials. (B.O.G.)

28872 (PWA-1994) DETERMINATION OF THE EMISSIVITY OF MATERIALS. Progress Report, April 1, 1961 through June 30, 1961. (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Contract NASw-104. 57p.

A summary is presented of work conducted in support of NASA space power systems. The finned-tube radiator segment endurance rig was completed and 17 coatings were tested in the aluminum plate thermal cycling rig. The total emittance of four materials was measured at various temperatures in a high vacuum. The specimens tested had surfaces of aluminum phosphate, aluminum oxide applied by three different methods, boron nitride, and lithiated and oxidized nickel "C". The coatings of aluminum phosphate and lithiated and oxidized nickel "C" had total emittance values above 0.80. Endurance tests were conducted on the aluminum phosphate and the lithiated and oxidized nickel "C" coatings. (auth)

28873 (TID-3092) NUCLEAR EXPLOSION EFFECTS ON STRUCTURES AND PROTECTIVE CONSTRUCTION. A Selected Bibliography. John H. Mitchell, comp. (Office of Technical Information Extension, AEC). Apr. 1961. 61p.

References on the effects of nuclear explosions on military, industrial, commercial, residential, and shelter structures are presented in this survey. Also included are abstracts to literature on design of protective structures such as bomb shelters, military installations, and buildings. A total of 240 selected references with author, report number availability, and subject indexes are given. (auth)

28874 (UCRL-8816) LECTURES ON PHYSICS, BIOPHYSICS, AND CHEMISTRY FOR HIGH SCHOOL SCIENCE TEACHERS GIVEN AT THE ERNEST O. LAWRENCE RADIATION LABORATORY, BERKELEY, CALIFORNIA, JUNE-AUGUST 1959. Edward C. Calhoun and Paul W. Starring, eds. (California, Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1959. 159p.

Lectures given at the Ernest O. Lawrence Radiation Laboratory on physics, biophysics, and chemistry for high school science teachers are presented. Topics covered include a mathematics review, atomic physics, nuclear physics, solid-state physics, elementary particles, anti-particles, design of experiments, high-energy particle accelerators, survey of particle detectors, emulsion as a particle detector, counters used in high-energy physics, bubble chambers, computer programming, chromatography, the transuranium elements, health physics, photosynthesis, the chemistry and physics of virus, the biology of virus, lipoproteins and heart disease, origin and evolution of the solar system, the role of space satellites in gathering astronomical data, and radiation and life in space. (M.C.G.)

28875 (WT-1472) EFFECTS OF A PRECURSOR SHOCK WAVE ON BLAST LOADING OF A STRUCTURE. J. R. Banister and L. J. Vortman (Sandia Corp., Albuquerque, N. Mex.). Oct. 1960. 71p. Project 34.1 [of] OPERATION PLUMBBOB.

A 6- by 6- by 20-ft structure located at a distance of 2000 ft from Ground Zero (GZ) was subjected to a precursor wave from the Priscilla shot, a 37-kt balloon shot detonated at an altitude of 700 ft. The wave struck a 6- by 20-ft face of the structure with a peak incident overpressure of between 24 and 26 psi. Free-field measurements of overpressure, dynamic pressure, and force were made at the same radial distance about 25 ft from the end of the structure. Local asymmetries in the blast wave gave different incident conditions for points separated on a fixed radius by only 35 ft. Dust concentrations and dust momentum flux were higher close to the ground than at the 10-ft-high gauge station located near the structure and contributed significantly to the blast loading on the front of the structure. This dust was accelerated through a high-velocity flow that feeds downward to the lower layers. The unusual oscillation seen in records of overpressures on the structures in earlier tests was again observed. A relation between the incident overpressure and the ratio of the impulse of the structure to the incident impulse is suggested. Similar measurements were made on a 9²/₃- by 11- by 17-ft structure located at a distance of 1150 ft from GZ, where the peak overpressure was 87 psi. (auth)

28876 (JPRS-8770) FIVE YEARS OF WORK AT THE JOINT NUCLEAR RESEARCH INSTITUTE. D. I. Blokhintsev. Translated from Atomnaya Energ., 10: 317-42(1961). 46p.

The progress during the years from 1956 to 1961 is reviewed, and the present status and future plans are outlined. The Institute is composed of Nuclear Problems, High-Energy, Neutron Physics, Nuclear Reaction, and Theoretical Physics Laboratories, and a Calculations Center. The research facilities at these laboratories (accelerators, reactors, etc.) are described. (T.F.H.)

28877 ADVANCES IN SPACE SCIENCE AND TECHNOLOGY. VOLUME 3. Frederick I. Ordway, III, ed. New York, Academic Press, 1961. 491p. \$14.00.

Eight papers are included; separate abstracts have been prepared for two. Of the six articles not abstracted, four have the astronomical objective of exploring the Moon,

Venus, Mars, Mercury, the asteroids, the other major planets and their satellite systems, and Pluto. Other papers are on the study of interplanetary matter, structures of carrier and space vehicles, and the aspects of weightlessness. (N.W.R.)

28878 INTERPLANETARY MATTER. Edward Manning (Geophysics Corp. of America, Bedford, Mass.). p.273-96 of "Advances in Space Science and Technology. Volume 3." New York, Academic Press, 1961.

A study is made of the nature of interplanetary material from numerous measurements and observations. Most measurements are made from the earth and by far the majority have utilized the earth or its atmosphere as a detector. Such measurements include visual observations of light from fireball and meteor trails as objects impinge upon the earth's atmosphere at high velocity. More quantitative information is obtained by photographing this light or by studying radar reflections from ionized gas along the trajectory of such objects. From these measurements, information is obtained on the velocity and distribution of the matter. A description is also given of the various spaceborne micrometeorite detectors along with the type of measurements for which they are suited. These detectors include the microphone, abrasion detectors, penetration or puncture detectors, and other related types. (N.W.R.)

28879 ADVANCED NUCLEAR AND SOLAR PROPULSION SYSTEMS. William C. Cooley (National Aeronautics and Space Administration, Washington, D. C.). p.421-42 of "Advances in Space Science and Technology. Volume 3." New York, Academic Press, 1961.

A review is given of the status of research and development and the potential applications of nuclear and solar energy for propulsion of spacecraft. The review serves as a guide to the literature and points out the problems and potentialities of each type of propulsion system. The advantages and disadvantages of each system are discussed in relation to the conditions for which they are needed. (N.W.R.)

28880 PEACETIME USES OF ATOMIC ENERGY. Revised Edition. Martin Mann. New York, The Viking Press 1961. 191p.

Some of the most important and most interesting ways in which atomic energy has proved its value to modern life are described. There is no mathematics and technical words are used only when equivalent common words do not exist. There is a glossary, but it is intended mainly to serve as a reference and to list some of the more widely used technical terms that were purposely avoided in the text. (N.W.R.)

BIOLOGY AND MEDICINE

General and Miscellaneous

28881 (CRDLR-3049) AIR BLAST STUDIES WITH ANIMALS. [PART] II. R. S. Anderson, Fred W. Stemler, and Earl B. Rogers (Army Chemical Research and Development Labs., Army Chemical Center, Md.). Apr. 1961. 63p. (DASA-1193)

Goats under Nembutal and mice were exposed in a shock tube modified to give longer-duration overpressures and equipped with ports for photography. Except for ear damage, displacement still seemed to be the major cause of injury in goats in the 4-foot section of the tube. However, it was found that mice were killed, apparently by pure blast, in a particular position in a particular type of side chamber attached to the higher-pressure, smaller-diameter, section of the tube. The relation between maximum velocity of displacement and the distance animals were thrown was fairly regular. The probability of injury over different terrains is discussed. (auth)

28882 (NP-10511) LONG-TERM RAT FEEDING STUDIES: IRRADIATED SHRIMP AND ORANGES DIET. Final Report. A. W. Phillips, H. R. Newcomb, and D. Shanklin (Syracuse Univ., N. Y. Biological Research Labs.). June 15, 1961. Contract DA-49-007-MD-791. 50p.

Toxicological evaluations of irradiated shrimp and oranges were conducted on albino rats during a two-year feeding program. The effect of radiation dose was determined by feeding each of the foods after treatment with two different radiation levels. Weight gains, food consumption, feed efficiency, and body weights were comparable among rats receiving the non-irradiated and irradiated foods. Breeding performance was normal in all three generations tested and no significant differences in the various parameters were observed except for a lower weaning weight index in some of the irradiated groups. Survival time or longevity of parent generation rats showed no significant differences between the non-irradiated and irradiated groups. Hematological values were generally within normal range for all generations studied in both diet groups. The effects on several duodenal enzymes of rats were investigated and no marked responses were observed. (M.C.G.)

28883 (NP-10512) TO DETERMINE THE EFFECT OF IRRADIATION UPON THE WHOLESOMENESS OF FOOD. Progress Report No. 11, September 1960–March 1961. Final Report on: THE EFFECT OF IRRADIATION UPON THE WHOLESOMENESS OF FLOUR. Elwood F. Reber, O. P. Malhotra, H. W. Norton, and J. Simon (Illinois. Univ., Urbana. Coll. of Veterinary Medicine and Illinois. Agricultural Experiment Station). Mar. 1961. Contract DA-49-007-MD 72800. 49p.

A long-term animal feeding study was carried out to determine the wholesomeness of wheat flour irradiated with 37,200 and 74,400 rads. Six male and 6 female beagles were used. The dogs fed irradiated flour weighed an average of 213 gm less at the beginning of the experiment, ate an average of 743 gm less, and gained an average of 859 gm more during the 24 week growth period and had better feed conversion than those fed non-irradiated flour. Reproduction and lactation studies showed that the number of pups whelped appeared to be approximately what would be expected. The percentage of pups weaned of those born was

quite low in all treatments. The dogs had a tendency to obesity and the birth weights of the pups were high. Experiments carried out to study the effects of irradiated food on the hemorrhagic syndrome in rats are also discussed. (M.C.G.)

28884 (NP-10513) EFFECT OF FOOD PRESERVED WITH IONIZING RADIATION ON RESTORATION OF ENZYME ACTIVITY AND TOTAL PROTEIN OF RAT LIVER. Final Summary Report, January 1, 1958–December 31, 1960. Otto Rosenthal (Pennsylvania. Univ., Philadelphia. School of Medicine). Contract DA-49-007-MD-861. 7p.

Results of seven series of short-term depletion-repletion experiments which aimed at appraising the efficacy of radiation-sterilized beef to restore hepatic protein and hepatic enzymes of protein-depleted young adult male Wistar rats are summarized. The enzymes studied were rhodanese, glucose-6-monophosphatase, and cyanide-resistant alkaline phosphatase. The conclusion was reached that canned ground raw beef sterilized with ionizing radiation at 5.6 megarad and incubated at 37°C for three weeks when incorporated into rations supplemented with minerals and vitamins was as effective as control beef and non-incubated irradiated beef in restoring protein content and enzyme activity of rat liver after protein depletion alone or followed by partial hepatectomy. In preparation for additional test series with three months' incubated radiation-sterilized beef, the intracellular localization of hepatic transaminases was investigated. It was found that there are two hepatic glutamic-oxaloacetic transaminases of different chemical properties, one situated in the mitochondria and the other in the soluble phase of cytoplasm. The mitochondrial enzyme was solubilized and conditions for the assay of the two enzymes were worked out. (auth)

28885 (NP-10514) INVESTIGATIONS TO DETERMINE THE MECHANISM FOR PRODUCTION OF THE HEMORRHAGIC SYNDROME WHICH DEVELOPS IN MALE RATS THAT RECEIVE DIETS CONTAINING IRRADIATED BEEF. General Progress Report XVII [on] A LONG RANGE INVESTIGATION OF THE NUTRITION PROPERTIES OF IRRADIATED FOODS, SEPTEMBER 1960 TO MAY 1961. L. R. Richardson (Texas. Agricultural Experiment Station, College Station). Contract DA-49-007-MD-582. 11p.

The procedure for developing the hemorrhagic syndrome in male rats was standardized. The experimental period was six weeks. Animals which died were autopsied for the occurrence of spontaneous hemorrhages. Plasma prothrombin times were determined on all animals surviving 6 weeks. Those with prothrombin times over 20 seconds were considered as hemorrhagic. Non-irradiated (control) and irradiated soybean protein (ADM assay protein C-1) was used in all the tests described. Hemorrhages developed in rats receiving control protein, but the incidence was less than in those receiving the irradiated protein. The level of dietary protein had a marked influence on the incidence of the hemorrhages. With 12% irradiated protein only 10% of the rats developed hemorrhages, while with 40% irradiated protein, 80% or more were hemorrhagic. The incidence of hemorrhages in rats receiving 60,000 IU of vitamin A per kilogram of diet was consistently higher than that in rats receiving 30,000 units. Addition of 4.0% of a mixture containing 13 pure amino acids appeared to decrease the incidence of hemorrhages in rats receiving 40% irradiated soybean protein. A mixture of glutamic acid, cystine and

glycine did not have any consistent effects on the hemorrhages. The incidence of hemorrhages was higher in male rats from mothers receiving 3000 IU/kg of vitamin A and no added vitamin K than it was in those from mothers receiving 30,000 IU vitamin and 7.5 mg menadione/kg. The young received the standard hemorrhagic producing diet containing 25% of irradiated soybean protein. (auth)

28886 (NP-10515) THE GROWTH, BREEDING, LONGEVITY AND HISTOPATHOLOGY OF RATS FED IRRADIATED OR CONTROL FOODS. Summary Report. ROOM TEMPERATURE STORED IRRADIATED JAM. Edward C. Bubl, Ira J. Tinsley, Joseph S. Butts, and Jesse F. Bone (Oregon State Coll., Corvallis). Jan. 3, 1961. Contract DA-49-007-MD-580. 15p.

Rations containing 35% dry solids of control or irradiated jam were fed to 4 generations of rats. Statistical analysis of the data revealed no treatment effects with respect to growth, breeding, longevity, or hematology. Analysis of the longevity data indicated that on the jam ration the female animals lived for a longer period than the males. (auth)

28887 (NP-10516) COMPONENTS OF IONIZED IRRADIATED MEATS INJURIOUS TO REPRODUCTION. Progress Report No. 1. C. M. McCay and G. L. Rumsey (Cornell Univ., Ithaca, N. Y.). Mar. 15, 1961. Contract DA-49-007-MD-600. 4p.

A 3-yr feeding program was carried out to determine if ground beef irradiated at a level of 6 million rads contains components injurious to reproduction in dogs. Growth curves and hematological results are discussed. There did not appear to be any significant differences between the diet groups. (M.C.G.)

28888 (NP-10518) LONG TERM FEEDING OF IRRADIATED POTATOES. PART II: PATHOLOGY. Final Report. B. E. Kline, H. Von Elbe, and J. J. Birdsall (Wisconsin Alumni Research Foundation, Madison). [nd]. Contract DA-49-007-MD712. 13p.

Results of the feeding of gamma irradiated potatoes to rats for a two-year period are discussed. The pathological findings other than incidence of mammary tumor were very low and were consistent with the usual picture of aging rats. Approximately 35% of the females developed mammary tumors. This was within the expected range for Sprague-Dawley rats on a moderately high fat diet. (M.C.G.)

28889 (NP-10519) ON THE NUTRITIVE VALUE OF THE MAJOR NUTRIENTS OF IRRADIATED FOODS AND APPRAISAL OF THE TOXICITY OF IRRADIATED FOODS. Progress Report No. 19, September 1, 1960-March 1, 1961. P. B. Rama Rao, A. M. Paolucci, and B. Connor Johnson (Illinois Univ., Urbana). Contract DA-49-007-MD-544. 23p.

Estradiol injected into male rats kept on a vitamin K-free diet was effective in lowering the plasma prothrombin time to normal values in about 6 hours. This vitamin K-like activity was observed even at a dosage of 20 μ g/rat. Conversely, testosterone administration (1 mg/rat) to female rats increased significantly the plasma prothrombin time as compared to the untreated control. Unlike the effects observed with rats, male and female chicks were equally susceptible to dietary vitamin K deficiency, and estradiol administration, even at a dose of 1 mg/chick, did not alleviate the hypoprothrombinemia. In rats with vitamin K deficiency, as indicated by the prothrombin time, no clear difference in the efficiency of oxidative phosphorylation between mitochondria isolated from normal and K-deficient animals could be detected. (M.C.G.)

28890 (NP-10520) LONG-TERM DOG-FEEDING OF IRRADIATED AND CONTROL FOODS AND ITS EFFECT UPON THE BLOOD SERUM CONSTITUENTS (PHASE 1) AND NUTRITIVE VALUE OF IRRADIATED PROTEINS AND CONTROL PROTEINS (PHASE 2). Progress Report No. 8, Period-6-Month Period Ending March 15, 1961. D. F. Watson, R. M. Smibert, and R. W. Engel (Virginia. Agricultural Experiment Station, Blacksburg). 13p. Contract DA-49-007-MD-784.

Six aged dogs and 6 puppies were fed diets including irradiated shrimp and the effects on blood serum constituents were observed. The averages of serum protein values as shown by paper electrophoresis and the blood chemistry data are presented in tabular form. An investigation of the antigenic response of dogs fed irradiated food to a soluble protein antigen was initiated. (M.C.G.)

28891 (NP-10521) HEMORRHAGIC SYNDROME IN RATS FED IRRADIATED BEEF. Progress Report No. 5, September 15, 1960 to March 15, 1961. E. A. Doisy, Jr. and J. T. Matschiner (Saint Louis Univ. School of Medicine). Contract DA-49-007-MD-996. 17p.

Mechanisms involved in the etiology of hemorrhage in rats fed irradiated beef were studied. It was found that certain oxidized lipids, especially squalene and vitamin A acid, are hemorrhagenic. Various proteins exerted very different effects in producing hypoprothrombinemia. Hemorrhagenicity was generally intensified by lipid extraction but the difference between casein and soybean protein was still observed. Preparation and preliminary metabolic studies of radioactive vitamin K₁ were carried out. (auth)

28892 (NP-10522) LONG-TERM DOG AND RAT FEEDING EXPERIMENT EMPLOYING IRRADIATED MILK AND BEEF STEW (C-RATION). Progress Report No. 8, September 15, 1960 to March 15, 1961. William B. Deichmann (Miami Univ., Coral Gables, Fla. School of Medicine). Contract DA 49-007-MD-785. 16p.

Studies were carried out to determine the chronic toxicity to dogs and rats of irradiated beef stew (C-Ration) and evaporated milk. No toxic effects as reflected in longevity, food consumption, growth, reproduction, or hematological data were observed. Dogs fed irradiated diets fared better in these experiments than dogs on control diets, but the difference was not considered significant. (M.C.G.)

28893 (NP-10523) MOUSE CARCINOGENICITY STUDY. Progress Report, March 1, 1957-March 15, 1961. William B. Deichmann (Miami Univ., Coral Gables, Fla. School of Medicine). Contract DA-49-007-MD-789. 11p.

Studies were carried out to determine whether foods sterilized by irradiation are likely to be carcinogenic by oral ingestion. Four different strains of mice were used in this experiment. The foods used were tuna, sweet potatoes, fruit compote, beef, and corn. No increase in tumor incidence due to the effect of irradiated food was apparent. (M.C.G.)

28894 (NP-10524) THE EFFECT OF CONTROL-GROUND BEEF AND IRRADIATED 5.58 MEGARAD-GROUND BEEF CONSUMPTION ON REPRODUCTIVE PERFORMANCE IN THE BEAGLE. Progress Report No. 2, September 15, 1960-March 15, 1961. Thomas B. Clarkson and John C. LeMay (Wake Forest Coll., Winston-Salem, N. C. Bowman Gray School of Medicine). Contract DA-49-193-MD-209A. 5p.

Studies were made to determine the effect of feeding meat preserved by irradiation on the reproductive performance in beagle dogs. No significant difference in body

weights gained, food consumption, or hematological and urine analyses was observed between the test and control groups. Results indicated that test females reached oestrus somewhat before controls. (M.C.G.)

28895 (NP-10525) REPORT OF FINDINGS [ON] RADIATION AND STERILIZATION OF FOODS FOR GEORGIA COASTAL PLAINS EXPERIMENT STATION AND UNIVERSITY OF GEORGIA COLLEGE OF AGRICULTURE, TIFTON, GEORGIA. Report Period: Ending March 15, 1961. F. D. Maurer (Armed Forces Inst. of Pathology, Washington, D. C.). 14p.

The effects of irradiated cabbage and bacon on dogs were studied. There was no evidence that the consumption of irradiated bacon or cabbage produced any histopathologic change that can be attributed to the specific food or level of irradiation. Lymphocytic thyroiditis was the most unusual findings. The condition was noted in both feeding programs and in all experimental diet groups including controls. (M.C.G.)

28896 (NP-10529) THE GROWTH, BREEDING, LONGEVITY AND HISTOPATHOLOGY OF RATS FED IRRADIATED OR CONTROL FOODS. Summary Report. ROOM TEMPERATURE STORED IRRADIATED FLOUR STATISTICAL ANALYSIS OF CARROT EXPERIMENT. Ian J. Tinsley, Edward C. Bubl, Joseph S. Butts, and Jesse F. Bone (Oregon State Univ., Corvallis). Mar. 15, 1961. Contract DA-49-007-MD-580. 17p.

Rations containing 35% control or irradiated flour were fed to four generations of rats. Statistical analysis of the data revealed no treatment effects with respect to growth, breeding, or longevity. A study of the hematology data also indicated no treatment differences. However, at 98 days the mean weights of animals of 3 generations were significantly different. Data from the long-term carrot feeding experiment were statistically analyzed. The following effects were observed in the animals raised on irradiated carrots: increased fertility, lower weights and weight gains than those fed unirradiated carrots, lower gross food intakes, and lower food efficiencies. (auth)

28897 (NP-10539) RADIOISOTOPES IN RADIATION PROCESSED FOODS. Period Covered by Report, September 16, 1960—March 15, 1961. (Vanderbilt Univ., Nashville. School of Medicine). Contract DA-49-193-MD-2101. 46p.

The efficiency calibration of the low-level counting facility for food in #10 and 2 cans was completed. Sample preparation for beta analysis is described. A normal photopeak fit with given analytical energy resolution parameters for photopeak efficiency calibration is presented. An analysis was made of radioactivity in non-irradiated pork. It was found that each kilogram of raw pork contains about 0.5 μg of Cs^{137} and 0.3 mg of K^{40} . The radioactivity in gamma irradiated pork using Co^{60} as a source was also determined. Gamma and beta analyses were made of 8- and 16-Mev electron irradiated pork. (M.C.G.)

28898 (NP-10554) THE INFLUENCE OF IRRADIATED FOODS ON THE ENZYME SYSTEMS CONCERNED WITH DIGESTION. Final Report, April 1, 1957—April 30, 1961. R. O. Moore (Ohio State Univ. Research Foundation, Columbus). Apr. 30, 1961. Contract DA-49-007-MD-787. 9p.

Studies were made to evaluate the influence of irradiation of foods on their susceptibility to digestion and their influence on the specific enzyme systems concerned in alimentary digestive processes. The *in vitro* studies were designed so that chemically pure substances which were considered representative macronutrient components of typical foods, were irradiated with soft x rays. Assays

were then made for the ability of these irradiated substances to serve as substrates for their representative digestive enzymes. Irradiation in the absence of water did not affect their susceptibility to digestion by purified enzyme systems. In aqueous solution the carbohydrates were partially hydrolyzed by irradiation, but this did not influence their further digestion. The digestion of proteins was increased and that of fats decreased by irradiation. The *in vivo* studies involved the feeding to rats of purified diets individual macronutrients components of which were irradiated prior to inclusion in the diet. Irradiation of starch reduced its digestibility, but it was improved by the presence of irradiated fat. The irradiation of protein did not affect its digestibility. The digestibility of fat was significantly reduced by irradiation when measured after prolonged feeding. (M.C.G.)

28899 (NP-10582) RADIATION PRESERVATION OF CRAB MEAT, SHRIMP AND OYSTERS. Maurice Bender (Fish and Wildlife Service. Fishery Technological Lab., College Park, Md.). [1958?]. 4p.

Cooked and raw forms of crab meat, shrimp, and oysters were irradiated and stored at three temperatures: 5, 35, and 70 to 80°F. Data indicated that cooked crab cakes are not much improved by either pasteurization or sterilization doses when stored at room temperatures or at 35°F. Studies showed that the storage time of raw peeled and deveined shrimp could not be increased by pasteurization or sterilization treatment. Flavor of the products was affected but not identically to individual taste panel members. (M.C.G.)

28900 (NP-10584) SUMMARY REPORT ON IRRADIATION PRESERVATIVE OF FISHERY PRODUCTS. Charles F. Lee and Mary E. Ambrose (Fish and Wildlife Service. Fishery Technological Lab., College Park, Md.). [nd.]. 1p.

Market forms of shrimp, oysters, and crab meat were selected for study of irradiation preservation. With one exception, irradiation with gamma rays was not found to hold promise as a means of preservation for the fishery products included in this investigation. The refrigerated storage life of the fresh picked meat of the blue crab could be prolonged from a normal maximum of 10 days to 3 months by irradiation at pasteurization levels of 0.50 to 1.0 megarads. The other products tested were, in general, adversely affected by any levels of irradiation which would prolong normal storage life. (M.C.G.)

28901 (NP-10597) A BIBLIOGRAPHY OF BIOLOGICAL APPLICATIONS OF AUTORADIOGRAPHY JULY 1, 1959 TO JANUARY 1, 1961. Reviews and Lectures No. 117. M. E. Johnston (Naval Radiological Defense Lab., San Francisco). July 28, 1961. 42p.

A bibliography on the biological applications of autoradiography is presented. The references are arranged in alphabetical order by author. (483 references.) (M.C.G.)

28902 (NP-10682) LECTURES IN AEROSPACE MEDICINE, JANUARY 16-20, 1961, CONDUCTED AT THE SCHOOL OF AVIATION MEDICINE, USAF AEROSPACE MEDICAL CENTER (ATC) BROOKS AFB, TEXAS. (School of Aviation Medicine. Aerospace Medical Center, Brooks AFB, Tex.). 552p.

Twenty three lectures on aerospace medicine are presented. Topics covered include biophysics of the space environment, celestial bodies, the upper atmosphere as observed with rockets and satellites, corpuscular radiations in space, bioradiology in space and in the laboratory, propulsion systems, the "G" spectrum in space flight dynamics, sealed cabin experimentation, experimental approach

to the psychophysiological problem of manned space vehicle. biological systems in space vehicles, sterilization of space vehicles, medical support at missile bases, biological experiments with space probes, radiobiological experiments in Discoverer satellites, Dyna-Soar pilot training, future extended space operations, and legal problems of future space explorations and travel. Separate abstracts were prepared for three of the papers. One was previously abstracted in NSA. (M.C.G.)

28903 (NP-10682(p.142-201)) BIO-RADIOLOGY IN SPACE AND IN THE LABORATORY. Roger Wallace (California. Univ., Berkeley. Lawrence Radiation Lab.).

Studies on heavy ions and their passage through matter are reviewed. Theories relating the velocity and charge state for a given ion in a given medium are discussed. It was found that the average charge of an ion increased with the pressure of a stopping gas up to a plateau value. This effect depended on the relative length of the average time between successive charge exchange collisions compared to the average time for radiation of the ion in an excited state. Capture and loss cross sections calculated for various heavy ions are shown. An outline of accelerator studies is presented. Biological experiments indicated that the heavy ions produce quite different effects from x rays. (M.C.G.)

28904 (NP-10682(p.481-90)) RADIOBIOLOGICAL EXPERIMENTS IN DISCOVERER SATELLITES. I. PHYSICAL DOSIMETRY. George W. Crawford, Joseph S. Piz-zuto, Loren C. Logie, Calvin R. Dexter, and Charles M. Kohr (School of Aviation Medicine. Aerospace Medical Center, Brooks AFB, Tex.).

Measurements of the radiation doses inside the Discoverer satellites are discussed. The dosimeters used are listed. Analyses were made of the data to identify the ionizing radiations producing the response in the dosimeters and to measure a meaningful dose. Results are summarized for Discoverers 17 and 18. (M.C.G.)

28905 (NP-10682(p.491-513)) RADIOBIOLOGICAL EXPERIMENTS IN DISCOVERER SATELLITES. II. CLOSTRIDIA SPORE LABILIZATION: A BIOLOGICAL SYSTEM TO QUANTITATE RADIATION. Irving Davis (School of Aviation Medicine. Aerospace Medical Center, Brooks AFB, Tex.).

Results obtained utilizing the Clostridia spore labilization system on biological specimens recovered from the Discoverer satellites 17 and 18 space flights are given. Data from both flights showed some degree of inhibition of the post-flight caramelized glucose treatment of the spores (percent labilization) compared to the ground controls. Studies showed that when similar spores were exposed to laboratory-controlled ionizing radiations and subsequently treated with caramelized glucose, the labilization effect is quantitatively inhibited. The equivalent radiation dose received by the flight ampules in each Discoverer mission was approximated from a laboratory-controlled radiation curve. (M.C.G.)

28906 (TID-7612(p.312-28)) DIAGNOSTIC RADIO-VITAMIN B₁₂-ADSORPTION AND RETENTION STUDIES WITH TEST-RADIOACTIVITIES WHICH ARE WITHIN THE RANGE OF THE NATURAL RADIOACTIVITY CONTENT OF THE HUMAN BODY USING THE LANDSTUHL 2 π -WHOLE BODY DETECTOR. H. C. Heinrich (Hamburg. Universität. Institut für Physiologische Chemie).

A *in vivo* radio-vitamin B₁₂-absorption whole-body retention test was developed which does not require collection of excreta and is so sensitive that test radioactivities

within the range of natural body radioactivities may be used. (D.L.C.)

28907 (TID-13358) OFFSITE ECOLOGICAL RESEARCH OF THE DIVISION OF BIOLOGY AND MEDICINE—TERRESTRIAL AND FRESHWATER. (Division of Biology and Medicine, AEC). June 1961. 146p.

Descriptions of research programs on terrestrial and freshwater ecology supported by the AEC are given. The publication is presented to acquaint those interested in the AEC biomedical program and its objectives and justification. Only off-site activities are described. (J.R.D.)

28908 (TID-13421) THE EFFECT OF PARATHYROID HORMONE ON CARBOHYDRATE METABOLISM. ([Loyola Univ., Chicago]). [nd]. 11p.

The effect of parathyroid hormone on carbohydrate metabolism is being studied with labeled glucose. In the extraction of organic acids from biological fluids, the method used involved the adsorption of a mixture containing intermediates of the tricarboxylic acid cycle on Celite followed by elution with ether. Details of the procedure for the chromatography of metabolic acids using batch-wise elution from silicic acid columns are described. Preliminary experiments with rats indicated no significant differences between animals injected with parathyroid hormone and control animals with respect to carbon dioxide expiration from the metabolism of labeled glucose. Another experiment indicated that the radioactive glucose remaining in the blood and bones was higher in the animal injected with parathyroid hormone. (M.C.G.)

28909 (TID-13564) A DIRECT EVALUATION OF PRODUCTIVITY IN ANIMAL POPULATIONS THROUGH THE DEVELOPMENT OF A NEW TRACER TECHNIQUE FOR ECOLOGICAL RESEARCH. Progress Report. (Wisconsin. Univ., Madison). 1961. 13p. Contract AT(11-1)-954.

Progress in an evaluation of productivity in animal populations through the development of a new tracer technique is reported. The problem of administering Ca⁴⁵ in a form that would release the active element over a protracted period at a relatively uniform rate and allow enough of the isotope to be carried over from hen to chick so that the radioactivity can be detected in the offspring during the first fall after hatching was solved by the use of delayed-reaction chemical combinations and mechanical retarders. The Ca⁴⁵ was converted to CaCO₃, CaC₂O₄, and Ca₃(PO₄)₂. These compounds were mixed with a lipoidal carrier (a cooking fat) and placed in gelatin capsules. The animal populations studied were pheasants, chickens, and rabbits. (M.C.G.)

28910 (TID-13650) NEW TRACER TECHNIQUES FOR EVALUATING THE EFFECTS OF AN INSECTICIDE ON THE ECOLOGY OF A FOREST FAUNA. Technical Progress Report No. 1, December 1, 1960—August 31, 1961. Tony J. Peterle and Robert H. Giles, Jr. (Ohio State Univ. Research Foundation, Columbus). Aug. 31, 1961. Contract AT(11-1)-967. 22p.

The development of trapping techniques for sampling forest fauna populations is described. The methods used to prepare S³⁵-labeled malathion are discussed. Progress is reported on the project for evaluating the effects of malathion spraying on the ecology of a forest fauna. (D.L.C.)

28911 (TID-13668) STUDY OF THE INHERITANCE OF PRODUCTIVE PROCESSES IN DOMESTIC ANIMALS BY ENDOCRINE METHODS USING RADIOACTIVE ISOTOPES AS TRACERS. Progress Report for 1960-61.

(Missouri. Agricultural Experiment Station, Columbia).
Sept. 1, 1961. Contract AT(11-1)-301. 10p.

Activities during the report period were devoted mostly to comparison of the thyroxine secretion rate (TSR) in cattle, swine, rams, rats, and chickens under various conditions. (J.R.D.)

28912 (UCLA-481) PREPARATION OF COLLOIDAL SUSPENSIONS OF HUMAN SERUM ALBUMIN I^{131} FOR ESTIMATING LIVER BLOOD FLOW AND RETICULO-ENDOTHELIAL SYSTEM FUNCTIONS IN MAN. G. V. Taplin, M. L. Griswold, and E. K. Dore (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). June 23, 1961. Contract AT-04-1-GEN-12. 19p.

Simplified methods for preparing 10 to 15 μ colloidal suspensions or aggregates of human serum albumin and of I^{131} -labeled albumin are described. The procedures may be performed by a single technician within a few hours. The labeled and unlabeled albumin aggregates were calculated to contain about 8 molecules per particle from the sedimentation constant ($S_{20} = 16.8$), determined from their ultracentrifuge boundaries. The electrophoretic patterns of both types of heat treated albumin show that the suspensions have less surface charge than the original solutions. This effect of heating is best explained by molecular aggregation which would reduce the net charge per molecule. Advantages of the heat treated albumin I^{131} are discussed. (P.C.H.)

28913 (UCRL-9806) TRACER STUDIES IN HYDROGEN-ADAPTED SCENEDESMUS USING H^3 AND C^{14} . Richard Allen Goldsby (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1961. Contract W-7405-eng-48. 75p.

The radioactive tracers H^3 and C^{14} were used to study the generation, properties and metabolic implications of Scenedesmus hydrogenase. The use of tritium in the exchange reaction catalyzed by hydrogenase makes it possible to make a direct, *in vivo* estimate of hydrogenase activity. A quantitative and qualitative study of carbon fixation in hydrogen-adapted Scenedesmus revealed the path of carbon from CO_2 to stable organic compounds. The kinetics of hydrogenase formation show that the full complement of hydrogenase is present after about three hours. Even after only five minutes of incubation under hydrogen, detectable amounts of hydrogenase are present. The studies with dithionite showed that lowering the reduction potential of the system accelerates the formation of Scenedesmus hydrogenase. The kinetics of hydrogenase formation suggest that its formation is an autocatalytic process. Units of hydrogenase formed earlier appear to facilitate the formation of subsequent units. Adapted Scenedesmus had a higher hydrogenase activity than the Chlamydomonas algae and more than representative members of two bacterial families. Scenedesmus hydrogenase exhibited the sensitivity to carbon monoxide and molecular oxygen shown by the hydrogenases found in bacterial systems. The sensitivity of Scenedesmus hydrogenase to CO and CN was a strong indication that a heavy metal prosthetic group is a critical component of the enzyme structure. An experiment with labeled hydrogen showed that Scenedesmus supplies electrons not protons from molecular hydrogen. In the CO_2 fixation experiments, the presence of active hydrogenase increased the quantity of carbon fixed and caused alteration in the path of fixation. The kinetic experiments showed that if an energy source is provided, CO_2 is fixed primarily along the outlines of the carbon reduction cycle. The ability of hydrogen-adapted Scenedesmus to use light to fix CO_2

when the Hill reaction is blocked by CMU was studied. The fact that photoreduction, an ATP requiring process, proceeds even in the presence of CMU indicated that hydrogenase can supply electrons to sites of the phosphorylating light reaction. It is possible that even in the absence of CMU the hydrogenase competes with the Hill reaction in supplying electrons for the phosphorylating light reaction. This would result in a lower quantum requirement for photophosphorylation during photoreduction than during photosynthesis. Clearly, hydrogenase had an effect, both quantitative and qualitative, on metabolic pathways. (auth)

28914 (AEC-tr-4776) PROBLEMS OF BIOCENOLOGY. H. R. Debauche. Translated for Oak Ridge National Lab. from Excerpt of Rev. questions sci. (Belg.-France), (5), 19: 58-89(1958). 41p.

The task of biocenology in giving a description and analysis of associations of elements living in close dependence of each other is discussed. Only the species which are actually a part of the biocenosis due to the activity exercised by them must be taken into consideration. Four fundamental categories which represent the trophic levels successively dependent on each other are autotrophic plants, phytophages, predators and parasites, and saprophages. The analyses of biocenosis are based on statistics. Conditions for sampling are outlined. Population density, spatial distribution, index of aggregation or contagion, type of distribution, index of expansion, distribution in time, dominance and biomass, index of association, differential criterion of Odum, diversity and stability, and index of diversity are discussed. (M.C.G.)

28915 (AEC-tr-4782) THE NUMBER OF CHROMOSOMES OF ERYTHROBLASTS. H. Weicker and K.-H. Terwey. Translated for Oak Ridge National Lab. from Klin. Wochschr., 36: 1132-8(Dec. 1, 1958). 23p. (Includes original, 7p.).

A formula was constructed which represents the quantitative relations between the volume of the cell nucleus and the degree of ploidy and taenia of the same cell. The difficulties which arise in the erythroblasts from the metrical findings and the morphological observation concerning the chromosome number are discussed. The chromosomes were counted in 242 proerythroblasts and erythroblast mitoses in Chinese dwarf hamsters. Within the erythropoiesis only the proerythroblasts were diploid, the same cells which, as was shown in earlier studies, can reproduce homoplastically. All erythroblasts were hypoploid. All erythroblast groups had a degree of hypoploidy which was characteristic only for them. Hypotheses are discussed as to how the process of hypoploidy formation might take place during erythroblast divisions. The special position of erythroblast mitoses compared to the reproduction divisions of somatic and the reduction divisions of generative cell systems is pointed out. (auth)

28916 (AEC-tr-4783) THE DIMENSIONAL, VOLUME, AND TIME STRUCTURE OF ERYTHROPOIESIS UNDER PHYSIOLOGICAL AND PATHOLOGICAL CONDITIONS. Heinz Weicker. Translated for Oak Ridge National Lab. from Schweiz. med. Wochschr., 87: 1210-18(1957). 51p. (Includes original, 10p.).

Quantitative factors were obtained by means of nucleus and cell measurements, mitosis counts, differentiations, and hematocrit determinations so that laws of erythropoiesis could be calculated. It was found that the diploid proerythroblasts continually reproduce by a generative division process, but at the same time form basophilic erythroblasts which are incapable of reproduction. It was determined that an additional 4 erythroblast generations exist

which derive from each other by divisions of the nuclear volume into halves and which become increasingly hypoploid from generation to generation. The generation period of erythroblasts on the average was 24 hr. The reticulocytes were $2\frac{1}{2}$ to 3 times as large and in the mature state contain twice as much hemoglobin as the erythrocytes. New results were also obtained for the pathogenesis of anemias. (M.C.G.)

28917 (JPRS-9663) ARCHIVES OF PATHOLOGY. Translation of Arkh. Patol., 23: No. 3, 3-33(Mar. 1961). 53p. (OTS-61-31,521).

Five papers translated from *Arkhiv Patologii* (Archives of Pathology) Vol. 23, No. 3, March 1961 are presented. Separate abstracts were prepared for four of the papers. (M.C.G.)

28918 ANALYSIS OF CONTINUOUS DOSAGE ISOTOPE EXPERIMENTS. Donald L. Buchanan (Veterans Administration Hospital, West Haven, Conn. and Yale Univ., New Haven). Arch. Biochem. Biophys., 94: 489-99(Sept. 1961).

The continuous dosage type of kinetic isotope experiment was partially analyzed mathematically to demonstrate the effects of various types of subdivisions and patterns of organization, as well as of variations of the turnover times of individual subdivisions on the specific radioactivity vs. time curves of complex organisms. Net and mean turnover times are defined and their graphic determinations from the specific radioactivity curves of the organism and the excrement are described. (auth)

28919 STORAGE BEHAVIOUR OF GAMMA-IRRADIATED MANGOES. P. B. Mathur and N. F. Lewis (Atomic Energy Establishment, Trombay, India). Intern. J. Appl. Radiation and Isotopes, 11: 43-5(Aug. 1961). (In English)

Fully grown and green Alphonso mangoes were picked and packaged in polyethylene bags individually, each bag having 12 respiration vents. Half of the fruit were irradiated with 12,000 rad of cobalt-60 gamma rays on the day of picking. The dose rate was 120 rad/min. The physiological losses in weight were lower in irradiated mangoes as compared to the controls. Data show that irradiation appeared to reduce the percentage of waste. On 10% wastage basis, the storage life of irradiated mangoes was about 24 days as compared to approximately 16 days for the controls when stored at room temperature. As a result of irradiation, part of the ascorbic acid content was destroyed. Data show that the content of non-reducing sugars was higher in the controls. No adverse effects on the color, taste, flavor, and texture of irradiated fruits were found. (N.W.R.)

28920 ROENTGEN THERAPY OF MALIGNANT TUMORS OF THE MEDIASTINUM WITH THE AID OF A LEAD GRILLE. O. F. Koroleva (Gertsen State Scientific-Research Inst. of Oncology, [USSR]). Med. Radiol., 6: No. 6, 3-10(June 1961). (In Russian)

The results are reported for x-ray therapy through a grill in 70 patients suffering from different malignant tumors of the mediastinum. The grill affords considerable increase of the single and total dose without subsequent injury of the tissues. This method exerts a favorable effect on the state of the patients with symptoms of compression of mediastinal organs. The remote results show that the use of a lead grill noticeably augments the terms of remissions. (auth)

28921 RADIUM THERAPY OF RETICULOSARCOMA. I. A. Pereslegin, N. A. Peresleni, and E. M. Filkova (State Scientific Research Roentgenology and Radiology Inst.,

Ministry of Health, RSFSR). Med. Radiol., 6: No. 6, 11-14 (June 1961). (In Russian)

An analysis is presented of 22 patients with diverse manifestations and localization of reticulosarcomas. In a number of patients the disease was manifested as an isolated affection, in others in the form of spreading processes. All 22 patients underwent routine x-ray therapy. The irradiation was effected in the principal focus of affection. When the process was localized in the lymph nodes of the mediastinum, the latter was irradiated from four fields (10×15 cm), the skin-focus distance was 50 cm, the filter — 1 mm Cu and 1 mm Al. At the beginning of treatment the single dose averaged 100 to 150 r and subsequently was increased to 250 r. The total dose comprised 2000 to 2500 r per field. Remissions lasted for 1 to 3 years. X-ray therapy undoubtedly exerts a favorable effect in reticulosarcoma, even when the process tends to spread. (auth)

28922 TELEGAMMATHERAPY OF CANCER OF THE LARYNX ON THE Co⁶⁰ APPARATUS. B. Ya. Yuditskii. Med. Radiol., 6: No. 6, 14-16(June 1961). (In Russian)

Irradiation of the larynx was instituted for a course of 5 to 8 weeks. Two or three fields were irradiated, the single dose averaging 200 to 250 r. The dose on the tumor amounted to 9400 r. The results of treatment depend on the localization of the tumor, distribution of the process, the sensitivity of the tumor to gamma rays, and on the irradiation dose. (auth)

28923 THE REACTION TO THE EFFECT OF RADIATION AND INJURY OF THE EYE IN RADIATION THERAPY OF SKIN TUMORS OF THE FACE AND EYELIDS. Yu. A. Bystrova (Central Scientific-Research Inst. for Medical Radiology, Ministry of Health, USSR). Med. Radiol., 6: No. 6, 17-22(June 1961).

Observations are reported concerning the reactions of eyes in 448 patients during x-ray therapy and shortly after, depending upon the employment of different irradiation techniques. The late results of eye injuries in 194 patients at periods ranging from 6 months to 17 years after x-ray therapy were studied. An opinion is set forth that the occurrence of reactions and injuries of the eyes is the result of inadequate protection during therapy. (auth)

28924 ON THE EXPEDIENCY OF AMBULATORY TREATMENT WITH RADIOIODINE. V. Ya. Golikov and I. I. Gusarov (First Moscow "Order of Lenin" Medical Inst.). Med. Radiol., 6: No. 6, 27-9(June 1961). (In Russian)

Based on studies of radiation doses from patients treated with radioiodine, it is concluded that ambulatory treatment with radioiodine should be restricted. In instances when ambulatory radioiodine therapy is feasible the patient should strictly observe a number of rules of personal hygiene for ensuring the safety of other persons contacting him. (auth)

28925 RADIATION ENERGY ABSORBED BY THE HUMAN ORGANISM DURING RADON BATHS. S. V. Andreev (Central Inst. of Health Resort Studies and Physiotherapy, USSR). Med. Radiol., 6: No. 6, 29-37(June 1961). (In Russian)

A method is described for determining the radiation energy absorbed by an organism during general and local radon baths. (auth)

28926 CARBON-14 FROM NUCLEAR EXPLOSIONS AS A SHORT-TERM DATING SYSTEM: USE TO DETERMINE THE ORIGIN OF HEARTWOOD. A. T. Wilson (Victoria Univ. of Wellington, N. Z.). Nature, 191: 714 (Aug. 12, 1961).

Carbon-14, produced in nuclear explosions and carried

into the stratosphere by the associated heat, diffuses slowly into the atmosphere. This phenomenon was used as a short-term dating system to study the mechanism of heartwood formation in trees. Results indicate that for a given ring of heartwood the extractives correspond in activity to the cellulose and not to the atmosphere at the time of their conversion from sapwood to heartwood. The activity of the cellulose corresponds to the activity of the atmosphere when it was the outer ring of the tree before nuclear explosions. It was shown that less than 6% of the carbon in the heartwood extractives in the outer ring of the heartwood comes from the atmosphere in the year of its conversion from sapwood to heartwood. (C.H.)

28927 A TECHNIC FOR CROSS-CALIBRATION OF X-RAY UNITS UTILIZING HALF-VALUE-LAYER DETERMINATIONS. Leon Pape, S. Baker, and Hyman L. Gildenhorn (City of Hope Medical Center, Duarte, Calif.). *Radiology*, 77: 480-5 (Sept. 1961).

A method for cross-calibration of radiographic installations, utilizing half-value layer and roentgen output, was devised. This enables reproduction of a given film quality on multiple x-ray units. The procedure provides for a possible system of universal calibration of radiographic installations. A major benefit derived from this system is the reduction or elimination of patient and personnel exposure. The comparability of radiographs taken on different units cross-calibrated in this manner is demonstrated. (auth)

28928 RADIOISOTOPES IN THE BIOLOGICAL SCIENCES. Getulio B. Viado. Manila, Philippine Atomic Energy Commission, 1960. 255p.

Discussion is given on the importance of radioisotopes, radiation injury, biological action of ionizing radiation, effects of enzymes and other substances, radiation protection with chemicals, biological and medical research, medical diagnosis and therapy, autoradiography, basic difficulties in tracer methodology, and radioisotopes in related biological fields including agriculture, pest control, agronomy, animal husbandry, forestry, and fisheries. Special emphasis is placed on the effects of radiation on various organisms in animals, insects, bacteria, yeasts, and fungi. The appendixes include information on the rules and regulations of the PAEC including the radioisotope laboratory, and acquisition, possession, and use of radioactive material. A radioisotope laboratory design is illustrated. 210 references are given. (P.C.H.)

Biochemistry, Nutrition, and Toxicology

28929 (NP-10517) EFFECT OF IONIZED RADIATION ON THE NUTRITIVE VALUE OF POTATOES AS DETERMINED BY GROWTH, REPRODUCTION, AND LACTATION STUDIES WITH DOGS. PART I. Final Report. C. M. McCay and G. L. Rumsey (Cornell Univ., Ithaca, N. Y.). Mar. 15, 1961. Contract DA-49-007-MD-600. 7p.

The effects of radiation on the nutritive value of potatoes were studied using beagle dogs. Studies included hematology, x-ray photographs of the bones, growth, and reproduction. It was found that potato, when included in the diet as 35% of the dry matter, does not constitute a nutritionally adequate diet for dogs. This was evidenced by poor growth and no reproduction. Normal adult weights were never attained by these dogs. It appeared that irradiation did not affect the nutritive value of potatoes as similar results were recorded on both the control and irradiated diets. (M.C.G.)

28930 (TID-13022) EFFECTS OF HEMORRHAGIC SHOCK ON VASCULAR PERMEABILITY TO RED BLOOD CELLS. Isaac Djerassi, Albert Roy, and Sidney Farber (Children's Cancer Research Foundation, Boston; Children's Hospital, Buffalo; and Harvard Univ., Boston. Medical School). July 1961. Contract AT(30-1)-1753. 23p.

The permeability of the blood vessel walls to red blood cells, as determined by changes of the red blood cell output in the lymph, was investigated in dogs in which hemorrhagic shock had been induced. Data are presented graphically. (C.H.)

28931 (TID-13023) TRANSFUSIONS OF FRESH PLATELET CONCENTRATES TO PATIENTS WITH SECONDARY THROMBOCYTOPENIA. Isaac Djerassi, Sidney Farber, Audrey Evans, and Hiroko Yoshimura (Children's Cancer Research Foundation, Boston; Children's Hospital, Buffalo and Harvard Univ., Boston. Medical School). July 1961. Contract AT(30-1)-1753. 22p.

Transfusions of fresh human platelet concentrates were given to 25 patients with thrombocytopenia secondary to acute leukemia and other blood diseases. The procedure increased the number of circulating platelets within 2 hr following infusion. No undesirable side effects were observed. (C.H.)

28932 (TID-13180) CELL MEMBRANE PERMEABILITY AND ACCUMULATION OF IONS. Progress Report and Six Year Summary of Research. Robert Ballentine and Dorothy D. Burford (Johns Hopkins Univ., Baltimore). July 1961. Contract AT(30-1)-1822. 64p.

Discussions are included of the objectives and research results of studies toward acquiring basic knowledge of the mechanisms which regulate the passage of elements into and out of cells, and to learn the mechanisms of their accumulation. Experimental results for calcium and strontium accumulation in *Tetrahymena pyriformis* substantiate a proposed hypothesis concerning the source of the necessary thermodynamic work for the accumulation, and the mechanisms of the accumulation. Significant results are discussed for research on the metabolism of calcium and strontium for: accumulation; intracellular distributions of the exchangeable and the non-exchangeable fractions; the effects of nutritional deficiencies and metabolic inhibitors on the metabolism patterns; and the influence of sulfadiazine on the growth and alkaline earth metabolisms, and their interrelations. (B.O.G.)

28933 (TID-13202) EFFECT OF *E. COLI* ENDOTOXIN ON RAT PLATELETS. (Children's Cancer Research Foundation, Boston; Children's Hospital, Buffalo; and Harvard Univ., Boston. Medical School). [1961]. 12p.

The administration of *Escherichia coli* endotoxin to rats was found to result in a gradual but profound decrease in the levels of circulating platelets. Possible reaction mechanisms involved are discussed. (C.H.)

28934 (AEC-tr-4794) DISTRIBUTION OF RADIOCERIUM IN LIVER CELLS AND THE INFLUENCE OF DIETHYLENETRIAMINEPENTACETIC ACID. A. Catsch, H. Immel-Teller, and D. Schindewolf-Jordan. Translated by Lydia Venters for Argonne National Lab., Ill. from *Z. Naturforsch.*, 16b: No. 3, 181 (1961). 9p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 15, abstract no. 19129.

28935 (AEC-tr-4796) MORPHOLOGICAL CHANGES IN SUNFLOWER AS A RESULT OF BORON DEFICIENCY. M. Ya. Shkol'nik and A. N. Maevskaya. Translated by Lydia Venters for Argonne National Lab., Ill. from Nauch.

Doklady Vysshei Shkoly Biol. Nauki, No. 1, 143-7 (1961). 8p.

The effect of boron deficiency on the morphology of four different kinds of sunflower plants was studied. After boron was eliminated from the nutrients, incised leaves and venation breaks in the leaves appeared; when boron was restored, the morphological changes disappeared. The implications of the results are discussed. (D.L.C.)

28936 (AEC-tr-4816) PROBLEMS IN THE CHEMICAL SYNTHESIS OF POLYNUCLEOTIDES. F. Cramer. Translated for Los Alamos Scientific Lab., Albuquerque, N. Mex. from *Angew. Chem.*, 73: 49-56 (1961). 43p.

A discussion of oligonucleotide synthesis is presented followed by data on individual syntheses. The diethyl ester of adenosine diphosphate and thymidinephosphate react as the triester to give polynucleotides. It is noted that in inclusion compounds, the pyrophosphate bond can be activated, and this reaction may be an explanation for the process which results in the identical replication of deoxyribonucleic acid and ribonucleic acid; the molecular surface of both compounds acting as stereospecific matrix and simultaneously activating the substrate which is absorbed to its surface. (J.R.D.)

28937 (JPRS-9663(p,22-9)) DEVELOPMENT OF EARLY MORPHOLOGIC CHANGES OF THE GASTRO-INTESTINAL TRACT AFTER THE ADMINISTRATION OF POLONIUM. G. A. Lebedeva. Translated from *Ark. Patol.*, 23: No. 3, 16-21 (1961).

An investigation was made of the morphologic changes of the gastrointestinal tract during the first 3 days after administration of Po^{210} . The experiments were performed on 25 white male rats, to which the polonium was given intravenously according to the calculation of 0.06 c per gram. The animals were killed 1, 3, 6, 12, 24, 48, and 72 hr after the beginning of the experiment. A study was also made of the condition of the mitotic activity of the jejunal crypts. The morphologic changes appeared during the first day after polonium injection. They consisted of the development of necrobiotic changes in the mucous membrane, a reduction in the mitotic activity in the epithelium of the small intestinal crypts, a change in the structure of the blood vessel walls, and aplasia of the lymph follicles. The earliest and most pronounced changes were noted in the small intestinal crypts and lymph follicles of the gastrointestinal tract. (M.C.G.)

28938 (UCRL-Trans-695) A POSSIBLE EXPLANATION OF ANOMALIES IN BIOLOGICAL ISOTOPE EFFECTS, OBSERVED BY BD_2O^{16} AND H_2O^{18} . S. Z. Roginski and S. E. Shnol'. Translated by Sergey Shewchuck for Univ. of California, Berkeley, from *Doklady Akad. Nauk S.S.S.R.*, 137: 706-9 (1961). 48p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 15, abstract no. 17906.

28939 NEUTRON-CAPTURE THERAPY IN A CASE OF CEREBELLAR SARCOMA TREATED INITIALLY WITH X-RADIATION. A CLINICAL AND HISTOLOGICAL STUDY. Lee E. Farr, Webb Haymaker, Wenceslao Calvo, Y. Lucas Yamamoto, and Stuart W. Lippincott (Brookhaven National Lab., Upton, N. Y. and Armed Forces Inst. of Pathology, Washington, D. C.). *Acta Neuropathol.*, 1: 34-55 (1961).

The case of a girl who was born with a large retroauricular mass diagnosed clinically as hemangioma is presented. It responded well to x-ray therapy. When she was 11 years old, a sarcoma was removed from the cerebellum. No evidence could be found that the sarcoma had originated from the retroauricular tumor. After the use of nitrogen mustard locally and three courses of x-ray therapy to the

tumor over a period of 9½ months with a total radiation dose of approximately 7953 r the patient was growing moribund. During 4 neutron-capture treatments, which were directed chiefly toward the suboccipital region, striking improvement occurred—to such an extent that the patient was able for a time to sit up in a wheelchair and converse. As a result of the therapy, all tumor which had spread suboccipitally and into the neck vanished, as did also virtually all tumor in the dorsal third of the cerebellum, the region receiving the largest concentration of thermal neutrons. In the middle third of the cerebellum large and small tumor aggregates, some of them calcified, were necrotic and were walled off by hyperplastic connective tissue. In the ventral third of the cerebellum, in a region presumably out of the range of an effective concentration of thermal neutrons, the tumor grew unimpeded. Evidence indicated that the sarcoma in this case originated in the vascular sheath, chiefly about vessels in the granular layer of the cerebellum. Life was prolonged approximately 8 months by the neutron-capture therapy. (auth)

28940 EXPERIMENTS WITH LITHIUM IN CHEMOTHERAPY OF CANCER. Jørgen Hastrup (Univ. of Aarhus, Denmark and Radium Centre for Jutland, Aarhus, Denmark). *Acta Radiol.*, 56: 124-8 (Aug. 1961). (In English)

Malignant homologous mouse tumors and 13 patients with malignant disorders were treated with lithium, which produced no antineoplastic effects. A diminished tolerance to lithium was observed both in the tumor-bearing mice and in the patients. (auth)

28941 THE TOXICITY OF BORON TRIFLUORIDE WHEN INHALED BY LABORATORY ANIMALS. T. R. Torkelson, S. E. Sadek, and V. K. Rowe (Dow Chemical Co., Midland, Mich.). *Am. Ind. Hyg. Assoc. J.*, 22: 263-70 (Aug. 1961).

Rats, rabbits, and guinea pigs were exposed seven hours per day, five days per week for periods up to six months duration to atmospheres containing boron trifluoride in concentrations calculated to be 12.8, 7.7, or 3.0 ppm. Analysis showed concentrations to be about one-half of these levels. The major effect of repeated inhalation was respiratory irritation causing injury ranging from death to a slight increase in pneumonitis. On basis of the study, a value of 0.3 ppm is tentatively suggested as a threshold limit value for boron trifluoride. (auth)

28942 PHYSIOLOGICAL EFFECTS OF DEUTERIUM ON DOGS. Dorice M. Czajka, Asher J. Finkel, Conrad S. Fischer, and Joseph J. Katz (Argonne National Lab., Ill.). *Am. J. Physiol.*, 201: 357-62 (Aug. 1961).

The physiological consequences of the deuterium isotope effect in large mammals were studied in two dogs, one of which was maintained at 20% concentration of D_2O in the body fluids for 50 days, and the other at the toxic range of 33-35% for a brief period. Deuteration of the dogs was effected by replacement of ordinary water with deuterium oxide in both food and drink. Hemoglobin, hematocrit, and red blood cell count dropped but the white blood cell count was essentially unaffected although there was a progressive lymphopenia and granulocytosis. Serum glucose was decreased, especially at higher deuterium levels. Total serum cholesterol values were also diminished although the esters were essentially unchanged. Serum sodium and both NPN and BUN were within normal limits except for a terminal elevation of the latter. Serum potassium was slightly lowered for a brief period after 3 weeks. Electrocardiograms showed ST segment coving and elevation and an increase in the QT ratio that suggested non-specific myocardial damage; these changes reverted to

normal while the dog was still deuterated at a level of 20%. Both dogs exhibited neuromuscular disturbances, in one case definite weakness of the hind legs and in the other, fine muscle tremors. (auth)

28943 SPLENIC SCINTILLATION SCANNING. Philip M. Johnson, Ernest H. Wood, and Steward L. Mooring (Univ. of North Carolina, Chapel Hill). *Am. J. Roentgenol., Radium Therapy Nuclear Med.*, 86: 757-67 (Oct. 1961).

The following conclusions are drawn from an investigation of splenic scintillation scanning in a series of patients with normal or diseased spleens: The splenic scintillation scan satisfactorily demonstrates the size, position, and configuration of the functioning spleen without interference from hepatic radioactivity. It establishes the presence or absence of splenomegaly and thereby permits differentiation of mass lesions in the left upper abdominal area. The technique of preparing red blood cells for the scanning procedure is clinically practical. There is no hematologic hazard to the recipient. The total radiation dose compares favorably to the amounts of radiation delivered in accepted clinical procedures using radioactive isotopes. Further applications of splenic scintillation scanning may include the identification of accessory splenic tissue and the localization of the impalpable spleen for procedures requiring splenic puncture. Measurement of the relative concentration of radioactivity in the spleen and liver has potential value as an index of a function common to these organs. (auth)

28944 COMPARATIVE FIXATION OF VARIOUS RADIOACTIVE PHOSPHOROUS SAMPLES BY BACTERIA. Antonina Guelin and Pierre Lepine (Institut Pasteur, Paris, France). *Ann. inst. Pasteur*, 101: 281-4 (Aug. 1961). (In French)

The fixation of P^{32} on killed bacteria varied greatly according to the sample used. The differences in the fixation seem to be independent of the specific radioactivity of the samples used and of their disintegration stage. (auth)

28945 DEUTERIUM ISOTOPE EFFECTS IN CHEMISTRY AND BIOLOGY. David Kritchevsky, ed. *Ann. N. Y. Acad. Sci.*, 84: 573-781 (Nov. 25, 1960).

Twenty-one papers are presented. One paper not abstracted includes a brief discussion on deuterium in biology. Nine papers were previously abstracted in *NSA*. Separate abstracts have been prepared for the remaining eleven papers. (P.C.H.)

28946 STEREOCHEMICAL AND KINETIC APPLICATIONS OF DEUTERIUM ISOTOPE EFFECTS. Andrew Streitwieser, Jr. (Univ. of California, Berkeley). *Ann. N. Y. Acad. Sci.*, 84: 576-82 (Nov. 25, 1960).

Several published and unpublished work concerning primary, secondary, and experimental deuterium isotope effects, rates of racemization and anharmonicity of deuterium labeled compounds, and the carbon-deuterium bond distance as compared to the carbon-hydrogen bond distance are discussed, analyzed, and illustrated. Some calculations, k_H/k_D , λ , k_D/k_T , k_H , k_D , and k_{rac} , are included. (P.C.H.)

28947 SECONDARY DEUTERIUM ISOTOPE EFFECTS IN CHEMICAL AND BIOCHEMICAL REACTIONS. V. J. Shiner, Jr., Henry R. Mahler, R. H. Baker, Jr., and R. R. Hiatt (Indiana Univ., Bloomington). *Ann. N. Y. Acad. Sci.*, 84: 583-95 (Nov. 5, 1960).

Information concerning the secondary isotope rate effect caused by deuterium substitution on the carbon atom next to the reaction center in carbonium ion type reactions is reviewed, and then some other examples of secondary

deuterium isotope effects in organic chemistry are summarized. Some new results on isotope effects in some enzyme-catalyzed hydrogen-transfer reactions are also given. (P.C.H.)

28948 ACID-BASE STUDIES WITH DEUTERIUM OXIDE. F. A. Long (Cornell Univ., Ithaca, N. Y.). *Ann. N. Y. Acad. Sci.*, 84: 596-602 (Nov. 25, 1960).

A detailed treatment is given of recent developments in the field of acid-base studies, with emphasis on the particular contributions of studies in D_2O to problems of acid-base catalysis. Discussion is mostly restricted to acid catalysis and is given in terms of the bimolecular mechanisms. Rate laws are given in concentration units. However, predictions for both acid and base catalysis are summarized. (P.C.H.)

28949 HELIX-RANDOM COIL TRANSFORMATIONS IN DEUTERATED MACROMOLECULES. Harold A. Scheraga (Cornell Univ., Ithaca, N. Y.). *Ann. N. Y. Acad. Sci.*, 84: 608-16 (Nov. 25, 1960).

From experiments it is apparent that deuteration leads to a measurable effect on the helix-random coil transition temperature for a particular protein and synthetic polypeptide. This effect provides evidence for the presence of internal hydrogen bonds in these macromolecules, and may also provide a clue as to the mode of action of D_2O in biological systems. In the particular examples cited, $\Delta H < 0$ for PBG, and deuteration decreases T_m ; $\Delta H > 0$ for ribonuclease, and deuteration increases T_m . Thus δT_m has the same sign as ΔH as a result of deuteration, implying that $\delta F > 0$ for these two systems. Also, in both systems, deuteration favors the helical form. However other examples will have to be considered before it can be determined whether this is a general property of hydrogen-bonded macromolecules. (auth)

28950 CHLOROPLAST PIGMENTS AND PHOTOSYNTHESIS IN DEUTERATED GREEN ALGAE. H. H. Strain, M. R. Thomas, H. L. Crespi, M. I. Blake, and J. J. Katz (Argonne National Lab., Ill.). *Ann. N. Y. Acad. Sci.*, 84: 617-33 (Nov. 25, 1960).

The isolation and characterization of deuterio-chlorophylls *a* and *b* from the chloroplasts of fully deuterated green algae, together with some preliminary observations on photosynthesis in deuterated algae, are described. An improved procedure is given for the isolation and purification of the chlorophylls. The algae used in the study were cultured for more than a year in a nutrient solution prepared from 99.8% D_2O . The infrared studies reported provide independent evidence that the chlorophyll made by the algae is essentially free of hydrogen. The ratio of deuterio-chlorophyll *a* to *b* in crude extracts of the deuterated algae was determined to be in the range 1.5:1 to 2:1. The uptake of $NaH^{14}CO_3$ by ordinary and deuterated *C. vulgaris* in H_2O and D_2O were measured, and the results are tabulated. (P.C.H.)

28951 THE EFFECTS OF DEUTERIUM OXIDE ON CERTAIN MICROORGANISMS. Rosali de Giovanni (Columbia Univ., New York). *Ann. N. Y. Acad. Sci.*, 84: 644-7 (Nov. 25, 1960).

The growth of several strains of *E. coli* and *B. subtilis* was inhibited by the presence of D_2O ; the degree of inhibition exhibited by each strain was specific. The addition of 0.5% NaCl to the D_2O media decreased the inhibition of growth. A deuterium-resistant mutant was obtained from one strain of *E. coli*. The incorporation of deuterium induces not only phenotypic but also genotypic changes in microorganisms. The effects induced by deuterium depend,

however, on the genotype of the strain. The isotope appears to be mutagenic for some strains and some loci but not for others. Various types of forward mutations were obtained in some of the bacterial strains tested and the frequency of backward mutation was increased in two strains exposed to deuterium. Thymine containing deuterium, possibly in its methyl group, is not capable of inducing any detectable changes in a thymine requiring mutant. Cells, grown in D_2O media and subsequently washed and irradiated in H_2O -saline, are more sensitive to ultraviolet irradiation than control cells. (auth)

28952 OBSERVATIONS ON THE INFLUENCE OF DEUTERIUM ON BACTERIAL GROWTH. William Lester, Jr., Sung Huang Sun, and Almera Seber (Suburban Cook County Tuberculosis Hospital-Sanitarium, Hinsdale, Ill.). Ann. N. Y. Acad. Sci., 84: 667-77(Nov. 25, 1960).

The influence of different concentrations of deuterium in liquid media on the growth of various microbial species was studied. The concentrations of deuterium studied ranged from 0 to 95 atom per cent. Cultures of *M. tuberculosis* showed inhibition of growth only when the deuterium concentration surpassed 80 atom per cent. Deuterium concentrations between 25 and 80 atom per cent appeared to stimulate growth slightly but this effect was not apparent until after 21 days incubation. Cultures of unclassified rapid-grower strain of acid-fast bacilli showed only progressive inhibition of growth with increasing concentrations of D_2O . On adequate media, cultures of Group C hemolytic streptococci demonstrated an inverse relationship between growth and deuterium concentration. On adverse media, the initial decline in bacterial population was inhibited progressively by increasing concentrations of deuterium, but after growth became established deuterium toxicity again became evident. Cultures of Type I pneumococci under poor conditions of growth showed evidence of a protective action of the higher concentrations of deuterium against the initial decline in bacterial population. Once growth became established it reached higher levels and persisted longer as the deuterium concentration was increased. The growth of *E. coli* was found to be progressively inhibited by increasing deuterium concentrations. Cultures of *Candida albicans* showed little sensitivity to increasing concentrations of deuterium. (auth)

28953 THE MUTAGENIC EFFECT OF D_2O ON BACTERIOPHAGE T4. Michael Konrad (Univ. of California, Berkeley). Ann. N. Y. Acad. Sci., 84: 678-84(Nov. 25, 1960).

E. coli and T4 phage were grown in MI media containing various concentrations of D_2O . Since the final phage titer attainable and the growth rate of the bacteria decreases sharply when the concentration of D_2O exceeds 50%, a more thorough investigation was carried out to test the mutagenic effect of 50% D_2O . It was found that this concentration of D_2O seems to exert no detectable effect on the forward mutation $T4r^+ \rightarrow T4r$. In reverse mutation, the ratio of r^+/rII phage in both 50 and 0% media remained constant throughout phage growth. The results suggest that the reverse mutation rate of some, though not all, rII mutants to the r^+ wild type can be significantly raised. (P.C.H.)

28954 STEREOCHEMICAL RELATIONSHIPS IN THE TRICARBOXYLIC ACID CYCLE: MECHANISM OF REACTIONS INVOLVING REVERSIBLE FORMATION OF CARBON-CARBON UNSATURATIONS. Sasha England (Yeshiva Univ., New York). Ann. N. Y. Acad. Sci., 84: 695-720(Nov. 25, 1960).

Some observations on the reactions within the tricarboxylic acid cycle involving the reversible formation

of carbon-carbon unsaturations are reviewed, and the results of a study on an anaerobic exchange of deuterium from the medium into succinate, as catalyzed by heart particle succinic oxidase preparations, are discussed in terms of the stereochemistry of the succinic dehydrogenase reaction. The stereospecific nature of the reversible hydrations of fumarate and cis-aconitate are described, and theoretical implications as regards the mechanism of the enzymatically catalyzed reactions are considered. Evidence is also presented that establishes the configuration of the product of the stereospecific enzymatic hydration of fumarate in D_2O in relation to the stereospecificity of the aconitase-catalyzed reaction. The consequences of the configurational interrelationship are shown to provide evidence for a trans fumarase-catalyzed addition reaction. (P.C.H.)

28955 EFFECTS OF D_2O ON CELLULAR COMPONENTS OF MAMMALIAN CELLS GROWN IN TISSUE CULTURE. Edward L. Rothstein, R. W. Hartzell, Jr., L. A. Manson, and David Kritchevsky (Wistar Inst., Philadelphia). Ann. N. Y. Acad. Sci., 84: 721-6(Nov. 25, 1960).

In respirometry experiments with HeLa cells, deuterium oxide caused an increased Q_{CO_2} and a reversal of the inhibition of the oxygen uptake normally seen with glucose. The results suggest that D_2O presents a new and useful tool for the study of certain aspects of lipid metabolism. (auth)

28956 THE INHIBITION OF MITOSIS BY DEUTERIUM. Paul R. Gross (New York Univ., New York and Marine Biological Lab., Woods Hole, Mass.) and Wiloiam Spindel. Ann. N. Y. Acad. Sci., 84: 745-54(Nov. 25, 1960).

Investigations of the antimitotic action of heavy water were carried out. It was observed that, depending on the conditions of deuteration, cell division in eggs of the sea urchin *Arbacia punctulata* could be delayed or arrested reversibly. The universality of the antimitotic action of D_2O is discussed. The five major types of proposals that were made to account for the biological effects of deuterium enrichment, and particularly for their interference with cell division, are outlined. (M.C.G.)

28957 THE EFFECT OF DEUTERIUM OXIDE ON ASCITES TUMOR GROWTH IN MICE. Asher J. Finkel and Dorice M. Czajka (Argonne National Lab., Ill.). Ann. N. Y. Acad. Sci., 84: 755-62(Nov. 25, 1960).

The growth of Krebs-2A ascites tumors in mice was appreciably depressed by the presence of deuterium in the body fluids in concentrations ranging from 13 to 32%. Measurement of the glutamic oxalacetic transaminase (GO-T) levels revealed that with increasing deuteration there was a progressive elevation of serum GO-T in tumor-bearing mice and an even more rapid rise of ascitic plasma GO-T. These data suggest that deuteration of the organism leads to tumor-cell injury with resulting release of GO-T into the ascitic fluid, whence it is carried into the general circulation. The notion that deuterium injures and possibly destroys mouse ascites tumor cells is supported, in part, by the terminal increase in the incidence of eosin-stainable tumor cells and, in part, by the absence of any striking difference in mitotic index of deuterated and nondeuterated tumor cells. These conclusions also apply to transplantable mouse ascites tumors. (auth)

28958 AN APPARATUS FOR CONTINUOUS MEASUREMENT OF $^{14}CO_2$ IN THE EXHALED AIR OF MEDIUM-SIZED AND LARGE DOMESTIC ANIMALS. Heiko Hörnicke (Tierärztlichen Hochschule, Hanover). Atompraxis, 7: 295-7(Aug. 1961). (In German)

Measurement of $C^{14}O_2$ in exhaled air is an important part of metabolism tests with compounds labelled with C^{14} . The following procedure was developed for tests using medium-sized and large domestic animals: the animal breathes through a mask into a constant-volume gas current, which is measured with a gas meter. Part of this gas current is drawn off, dried, and conducted through an ionization chamber to measure its activity. The CO_2 concentration of this part of the current is further measured with a heat-conductivity analyzer. Radioactivity and CO_2 concentration are registered continuously. The construction, operation, and tagging of this apparatus are described. It is used successfully for metabolism tests with urea and carbonate in goats, and can also be used for animal-chamber tests on smaller animals. (tr-auth)

28959 THE USE OF Fe^{59} AND Cr^{51} FOR ESTIMATING RED CELL PRODUCTION AND DESTRUCTION: AN INTERPRETIVE REVIEW. Frederick Stohlman, Jr. (U. S. Dept. of Health, Education and Welfare, Bethesda, Md.). *Blood*, 18: 236-50 (Aug. 1961).

A review is given of the uses of Fe^{59} and Cr^{51} , their quantitative limitations, and role in clinical medicine. The use of sodium chromate for estimating cell survival and of radioactive iron to estimate red cell production are discussed. The use of both isotopes entails some risk, the main hazards being hepatitis, with the use of donor plasma or cells, and the possibility of untoward effects from radiation. An estimate of the risk of hepatitis can be gained from its incidence after transfusion. (P.C.H.)

28960 THE ACCUMULATION AND ELIMINATION OF Sr^{90} AND Cs^{137} BY THE CADDIS FLY *HALESUS INTERPUNCTATUS* ZETT. A. B. Getsova and G. A. Volkova (Inst. of Zoology, Academy of Sciences, USSR). *Doklady Akad. Nauk S.S.S.R.*, 139: 483-4 (July 11, 1961). (In Russian)

Larvae of the caddis fly were placed in 5 liters of water which had been contaminated with about 1000 counts/minute of Sr^{90} or Cs^{137} . After 3 and 6 hours, 1, 4, and 8 days, a definite number of the insects were removed from the aquarium. Part of the insects were dried, weighed and counted in order to obtain the amount of Sr^{90} and Cs^{137} accumulated by the organism. The remainder of the insects were placed in clean water for 1, 4, and 14 days in order to determine the rate of decontamination. Activity determinations were made on both the cocoon and on the larva. The greatest amount of residual activity is left in both the cocoon and in the larva after an 8-day accumulation of activity as compared to a 3 or 6 hour accumulation of activity. Most of the desorption of activity from the cocoon takes place during the first day. The contamination in the larva is removed more slowly and uniformly. (TTT)

28961 CHOLINE OXIDASE IN FATTY LIVERS INDUCED BY CERIUM. F. Snyder and E. Gress (Oak Ridge Inst. of Nuclear Studies, Tenn.). *Experientia*, 17: 303-4 (1961). (In English)

The choline oxidase level in rat liver homogenates was measured after administration of Ce. The experimentally obtained values show that the fatty infiltration induced by the Ce depends neither on the type of rat nor on its hormonal state. In fatty livers, the enzyme inhibition appears to be determined more by the lipid content than by the cerium concentration. (tr-auth)

28962 THE USE OF TRITIATED THYMIDINE FOR MARKING MIGRATORY CELLS. J. P. Trinkaus and Marcie C. Gross (Yale Univ., New Haven). *Exptl. Cell Research*, 24: 52-7 (June 1961). (In English)

Tapetal cells, which may be readily distinguished by their melanin granules, were labeled with thymidine- H^3 and cultured with unlabeled mesonephric cells in mixed aggregates. During five days in culture there was insignificant transfer of isotope to unlabeled cells. In the reciprocal experiment, a small amount of transfer occurred, presumably due to cytolysis of certain labeled cells. It is proposed that thymidine- H^3 has potential usefulness as a marker for migratory cells. (auth)

28963 DETERMINATION OF Sr^{90} AND STABLE STRONTIUM IN BONES FROM SHEEP EWES AND THEIR FETUSES. S. Häggroth and G. Höglund (Karolinska Institutet, Stockholm). *Exptl. Cell Research*, 24: 80-7 (June 1961). (In English)

The concentrations of Sr^{90} and stable strontium were measured in the bone ash from pregnant sheep ewes and their fetuses. The fetuses weighed from 125 g (Sr^{90}) and 110 g (stable strontium) to 2650 g. In the ewes the average concentration of Sr^{90} was 40.4 (s.d. 6.4) pc/g calcium in the metatarsal diaphyses and 38.4 (s.d. 3.9) pc/g calcium in the vertebrae. The average concentration of stable strontium was 321 (s.d. 37) ppm in the metatarsal diaphyses and 324 (s.d. 26) ppm in the vertebrae. No significant difference between the two bones in the concentrations of either Sr^{90} or stable strontium was found. In the fetuses the average concentrations of Sr^{90} and stable strontium in the ash from the ossified parts of the long bone diaphyses was 16.2 (s.d. 2.5) pc/g calcium and 152 (s.d. 27) ppm respectively. The average ratio between the strontium concentrations in the long bones of each fetus and the metatarsal bones of its mother was 0.41 (s.d. 0.06) for Sr^{90} and 0.48 (s.d. 0.08) for stable strontium. The strontium concentrations in the fetal and maternal bone ash, and the ratio between these concentrations, were essentially independent of fetal weight and sacrifice date. (auth)

28964 ELECTRON MICROSCOPE AUTORADIOGRAPHY. R. J. Przybylski (Univ. of Chicago). *Exptl. Cell. Research*, 24: 181-4 (June 1961). (In English)

Experiments combining the techniques of tritium autoradiography with the high resolving power of the electron microscope in conjunction with an extremely thin section and overlying emulsion are discussed. Although autoradiographic techniques were successfully applied to ultra-thin sections and the high resolution of the electron microscope, silver grains of extremely variable size and complete electron opacity were encountered. (P.C.H.)

28965 RETENTION AND TRANSLOCATION OF RADIOACTIVE ZINC BY SALMON FINGERLINGS. Timothy Joyner and Ronald Eisler (Univ. of Washington, Seattle). *Growth*, 25: 151-6 (June 1961).

Twenty-five chinook salmon fingerlings were immersed for twenty-four hours in 5 liters of lake water containing 0.2 ppm of zinc labelled with 18.54 microcuries of zinc-65. Periodic assays of the gamma radioactivity in the fish showed that the rapidly growing fish removed approximately 2% of the radioactive zinc from the medium, and retained nearly all of it for 63 days after transfer to flowing lake water. The increase with time in the percent of the whole-body radioactivity contributed by the vertebral column, head, and visceral mass indicates an accumulation of zinc in these parts at the expense of the remainder of the fish. (auth)

28966 ALTERATION OF BORATE TOXICITY BY d-GLUCOSE. Otho D. Easterday and Lee E. Farr (Brookhaven National Lab., Upton, N. Y.). *J. Pharmacol. Exptl. Therap.*, 132: No. 3, 392-8 (June 1961). (BNL-4676)

By varying the molar ratio of borax to D-glucose, marked changes were produced in mortality of mice. The least toxic molar ratio was 1:1.5 to 1:2, borax:D-glucose. Under these conditions the intravenous LD₅₀ estimate of borax increased from 1320 to 1770 mg/kg. No sex differences in toxicity were found. Injection of the borax solutions within the temperature range of 42 to 55°C did not appreciably alter the toxicity. (auth)

28967 ABSORPTION OF I^{131} BY THE THYROID GLAND AND FUNCTIONAL DISTURBANCES OF THE LATTER IN CHRONIC EXPERIMENTS. V. L. Shvedov. Med. Radiol., 6: No. 6, 38-41 (June 1961). (In Russian)

The chronic absorption of I^{131} by the thyroid gland was measured. Experiments on rabbits show that the curve of radioiodine absorption by the thyroid gland in manifold daily introduction for a period of 30 days is of a three-phase character. The highest concentration of the isotope, with the exception of the thyroid gland, is seen in the lungs, in the gall bladder bile, trachea, and kidneys. The lowest concentration is in the brain, spinal cord, and bone marrow. (auth)

28968 EFFECT OF POLYVINYL ALCOHOL ON THE DISTRIBUTION OF IODINE-131 IN THE INTERNAL ORGANS, FLUIDS AND EXCRETA OF RABBITS. H. F. Nowak and J. Kucharski (Bialystok Medical Academy, Poland). Nature, 191: 665-7 (Aug. 12, 1961).

Data are presented graphically on the effect of polyvinyl alcohol on the distribution of I^{131} in the tissues of rabbits. Radioactive I, given with polyvinyl alcohol, concentrated in the thyroid gland six times greater than when given in physiological salt solution. Implications that doses of I^{131} may be reduced to a sixth, and thus reduce the pathological effects from radiation, are discussed. (C.H.)

28969 FAILURE OF A DOG TO DISCRIMINATE BETWEEN STRONTIUM-90 AND CALCIUM GIVEN ORALLY. Betsy J. Stover (Univ. of Utah, Salt Lake City), M. Goldman, and A. C. Andersen. Nature, 191: 713-14 (Aug. 12, 1961).

No discrimination in the metabolic use of Sr^{90} and Ca was observed in dogs fed a constant diet of Sr^{90} from the beginning of fetal ossification until the pups reached early adulthood. Data are tabulated on the concentration of Sr^{90} in bone. (C.H.)

28970 REMOVAL OF INTERNALLY DEPOSITED RADIONUCLIDES BY TRIETHYLENETETRAAMINE-HEXAACETIC ACID. A. Catsch and D. Schindewolf-Jordan (Institut für Strahlenbiologie, Kernforschungszentrum, Karlsruhe, Ger.). Nature, 191: 715 (Aug. 12, 1961).

The effectiveness of triethylenetetraamine-hexaacetic acid in removing internally deposited Ce^{144} , Y^{91} , or Sr^{85} was studied in rats. Data are tabulated and results are compared with those obtained using ethylenediaminetetraacetic acid as a chelate. (C.H.)

28971 INCORPORATION OF PHOSPHORUS-32 INTO URINARY CONCRETIONS FORMING ON ZINC IMPLANTS IN RAT BLADDERS. Richard F. Keeler and Stuart A. Lovelace (Montana State Coll., Bozeman). Nature, 191: 715-17 (Aug. 12, 1961).

Thirty rats were implanted with Zn pellets to induce the formation of urinary calculi. The rats were maintained on a normal diet with either Ca, K, or tetraethyl silicate supplement added. Tracer doses of P^{32} were given and radioautograms were made of stones removed at autopsy. Preliminary results indicate that this method offers promise in the study of the rate of formation of urinary calculi under experimental conditions. (C.H.)

28972 DETERMINATION OF CAESIUM-137/POTASSIUM RATIOS IN DIET AND IN THE HUMAN BODY BY URINE ANALYSIS. A. Morgan and Gloria M. Arkell (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nature, 191: 1100 (Sept. 9, 1961).

A radiochemical method was developed for the determination of Cs^{137} in urine. The sensitivity of the method makes it particularly useful for the determination of fallout Cs^{137} . The Cs^{137} and K contents of 7 urine samples collected in Berkshire in Feb., March, and April, 1961, were determined, and the results are tabulated. The mean ratio determined was 12.1. (P.C.H.)

28973 RESISTANCE AND CROSS-RESISTANCE OF *ESCHERICHIA COLI* MUTANTS TO ANTICANCER AGENTS NITROGEN MUSTARD AND NITROMIN. Pearl L. Woody, Joseph D. Mandell, and Joseph Greenberg (Stanford Research Inst., Menlo Park, Calif.). Radiation Research, 15: 290-7 (Sept. 1961).

The cross-resistance relationships among seven mutants of *E. coli* strain S selected for resistance to nitrogen mustard and nitromin are described. The data for two first-step nitromin-resistant mutants to seven radiomimetic chemicals, ultraviolet light, 6-diazo-5-oxo-L-norleucine, and penicillin are presented. Three qualitatively different radioresistant mutations were established on the basis of the cross-resistance to ultraviolet light and, hence, would be indistinguishable by this criterion alone. (auth)

28974 THE CORRELATION OF AUTORADIOGRAPHIC GRAIN COUNTS AND TRITIUM CONCENTRATION IN TISSUE SECTIONS CONTAINING TRITIATED THYMIDINE. Walter E. Kisielewski, Renato Baserga, and John Vaupotic (Argonne National Lab., Ill. and Northwestern Medical School, Chicago). Radiation Research, 15: 341-8 (Sept. 1961).

The correlation between the number of developed silver grains in an autoradiographic emulsion and the concentration of tritium atoms in the underlying cells was studied in tissue sections labeled *in vivo* with tritiated thymidine. The results indicate that, in a tissue section 3 μ thick, from 100 to 200 disintegrations of tritium atoms are required to render developable 1 silver grain in the emulsion overlying the labeled locus. (auth)

28975 TOXIC EFFECTS OF FLUORIDE ON THE RAT KIDNEY. I. ACUTE INJURY FROM SINGLE LARGE DOSES. Jean M. Taylor, James K. Scott, Elliott A. Maynard, Frank A. Smith, and Harold C. Hodge (Univ. of Rochester, N. Y.). Toxicol. Appl. Pharmacol., 3: 278-89 (1961).

The 30-day LD₅₀ of sodium fluoride administered intravenously as a 2% aqueous solution in the young rat (75 days old) was 26 mg/kg. The lethal action of sodium fluoride appeared to involve two mechanisms: one causing death in a few hours and the other in 3-10 days. Renal injury did not appear to be the cause of the delayed deaths. Single doses of sodium fluoride (20 and 30 mg/kg, intravenously) produced a mild necrosis of the tubular epithelium in the inner third of the cortex. The necrosis was evident on the first and third days after treatment. Regeneration began by the fifth day and was nearly complete by the ninth day. The renal lesion was relatively limited. A few rats receiving a single dose of sodium fluoride showed a dilatation of the tubules at the junction of the cortex and medulla. Renal functions were deranged temporarily by near lethal doses. A single dose of sodium fluoride of 20 or 30 mg/kg, intravenously, increased urine volume and decreased specific gravity. Sugar excretion was markedly increased the first day after treatment and then decreased below

mal for several days. Protein excretion was slightly reased. (auth)

**976 RADIOACTIVE ISOTOPES IN THE BIOCHEMIS-
Y OF THE NERVOUS SYSTEM.** A. V. Palladin (Inst. of
chemistry, Academy of Sciences, Ukrainian SSR).
rain. Biokhim. Zhur., 33: 602-21(1961). (In Ukrainian)
Applications of radioactive isotopes in studies of meta-
lic processes in the nervous system, particularly in the
ain, and their effects on certain functional changes are
viewed. Data reported in the USSR and in foreign publica-
ns are analyzed. 75 references are included. (R.V.J.)

**977 INHALATION OF URANIUM AEROSOLS BY
OUSE, RAT, DOG AND MAN.** Birney R. Fish (Oak Ridge
tional Lab., Tenn.). p.151-65 of "Inhaled Particles and
pours." New York, Pergamon Press, 1961.
Six cases of accidental inhalation of uranium compounds
re studied to compare various methods of estimating
dy burden. One accident, involving U_3O_8 , was re-
acted and an estimate of potential lung burden was de-
ved from air sampling data; this, along with estimates
sed upon blood analysis and urinalysis, compares with
vivo gamma counting results within $\pm 50\%$. Two cases
uranyl nitrate inhalation were analyzed by comparing
e individual uranium excretion rates with those of
elve humans given known intravenous injections, and
so by collecting all of the urine for long periods of time:
e estimates agree to within a factor of 2. Data obtained
om these accidental exposures, along with a field study
rrelating air contamination parameters and uranium
cretion levels for a variety of industrial jobs, were
ed to fashion a tentative empirical model relating body
rden to air contamination and to excretion. Dogs ex-
sed to a single inhalation of uranium fumes (U_3O_8) retain
proximately 25% of the inhaled material. About half of
e retained lung burden is eliminated rapidly with a biolog-
al half life of 4.5 days while the remainder is cleared at
e rate of one-half every 100 days. About 0.01% of the
ortion eliminated via the gastro-intestinal tract is ab-
orbed into the blood stream. The concentration of uranium
the tracheo-bronchial lymph nodes increases while the
ount in the lungs decreases so that after about 4 months
e uranium concentration in the lymph tissue exceeds that
n the lung. *In vitro* studies of the solubilities of U_3O_8 and
uranyl nitrate in an ultra-filtrate of blood as a function of
article size were initiated. Animal inhalation projects,
ow under way, are designed to simulate with mice, rats,
nd dogs the actual exposures presented to the human
subjects. Correlation of the industrial exposure data with
ne laboratory studies tends to support the empirical model.
(auth)

**28978 AN EXPERIMENTAL STUDY OF THE DEPOSI-
TION AND RETENTION OF A PLUTONIUM-239 DIOXIDE
AEROSOL.** P. E. Morrow and L. J. Casarett. p.167-75
f "Inhaled Particles and Vapours." New York, Pergamon
Press, 1961.

Twenty-one inhalation experiments were conducted on 17
logs in order to measure the amount of mass deposition oc-
curring and to determine the nature of the particles retained
n their respiratory tracts following a single exposure to
lutonium-239 dioxide aerosols. The subjects were divided
nto two groups according to the average characteristics of
he aerosol used; the average mass deposition was 56 and
88%, respectively. In neither group was it possible to find
a clear relationship between the respiratory parameters
measured and the mass deposition. Through the medium of
autoradiography the lungs of the first group of dogs (4)
were examined. It was found that during the period of time

studied, 16-125 days post-exposure, all of the known dust
clearance processes were active in the lung; these were
presumably all engaged directly or indirectly in parenchy-
mal clearance. Though quantification is not possible, it is
apparent that the lymphatics of the lung are an important
route of dust removal. Particle size estimates (track
counting) indicate that most (>90%) of the particles re-
tained in the lung were less than 0.2μ diameter. Some dif-
ferences in the relative clearance rates of particles ac-
cording to size were noted; the smallest particles ($<0.1\mu$)
apparently have the longest retention times. The signifi-
cance of certain distribution patterns is discussed partic-
ularly as they might apply to radiation dosage to specific
lung areas. (auth)

**28979 DEPOSITION, RETENTION, TRANSLOCATION
AND EXCRETION OF RADIOACTIVE PARTICLES.** W. J.
Bair (General Electric Co., Richland, Wash.). p.192-207
of "Inhaled Particles and Vapours." New York, London,
Paris, and Oxford, Pergamon Press, 1961.

Results from studies of the behavior and the biological
effects of inhaled radioactive particles were reviewed.
About 25% of inhaled $Ru^{106}O_2$ or $Pu^{239}O_2$ was deposited in
lungs of mice. Pulmonary clearance was described by a
series of exponential equations. The slow component,
less than 5% of the lung dose, has a biological half life of
230 days for Ru^{106} and 460 days for Pu^{239} . Greater reten-
tion of Pu^{239} in dogs was shown in excretion studies where
half-times for elimination were 1400 days or more. In
dogs, about half of the deposited dose of $Pu^{239}O_2$ was ex-
creted in feces the first two weeks after exposure. For
several weeks after exposure the highest concentration
of Ru^{106} and Pu^{239} was in lung. Gradual translocation
caused high concentrations of Ru^{106} to occur in ovary and
adrenal glands. Pu^{239} was found in high concentrations in
tracheobronchial lymph nodes. Inhalation of $Sr^{90}SO_4$,
 Ag^{131} , or I^{131} vapor was followed by immediate lung
clearance and translocation to the same tissues that ac-
cumulate the radioisotope following its entry by other
routes, skeleton for Sr^{90} and thyroid for I^{131} . Biological
effects of pulmonary deposited Pu^{239} or Ru^{106} included
several malignant lung tumors, gross lymphatic pathology,
and decreased circulating lymphocyte counts. Early death,
within a few months, followed deposition of $0.3\mu c Pu^{239}O_2$
in mice and between 50 and $100\mu c$ in dogs. Chronic in-
halation of $10^{-5}\mu c Sr^{90}SO_4/cm^3$ of air and less caused
minor hematological changes but no increased incidence
of leukemia. The significance of the data in evaluating the
hazards of inhaled radioisotopes was discussed. (auth)

Fallout and Ecology

**28980 (A/AC.82/G/L.586) CAESIUM 137 IN AIR,
PRECIPITATION, DRINKING WATER, MILK AND BEEF
IN NORWAY DURING 1959 AND 1960.** (Norway. Fors-
varets Forskningsinstitut, Kjeller). Feb. 11, 1961. 6p.
(FFIF/F-0043)

Cs^{137} in air, precipitation, drinking water, milk, and beef
was measured at Bergen, Røros and Lillestrøm, Norway.
The Bergen district is a mountainous coastal area, Røros
is a mountainous inland area, and Lillestrøm is a lowland,
inland area. The Cs^{137} concentration in air and precipita-
tion was at nearly the same level at all sites and variations
occurred simultaneously. The amount of precipitation var-
ied from site to site. Therefore the fall-out at Bergen was
about 5 times higher than at Røros and about twice as high
as at Lillestrøm. The average concentration in drinking
water was only a few percent of the average concentration

in precipitation. The concentration of Cs^{137} in milk at Bergen was about twice as high as at Røros and 7 times higher than at Lillestrøm. The variations in beef from district to district appeared to follow nearly the same pattern as for milk. (M.C.G.)

28981 (CLOR-7) AN ESTIMATION OF RADIATION EXPOSURE FROM FALLOUT. R. Szepeke (Poland. Biuro Pelnomocnika Rządu do Spraw Wykorzystania Energii Jadrowej. Centralne Laboratorium Ochrony Radiologicznej, Warsaw). Jan. 1961. 26p.

The exposure dosage for the population of Middle Europe, due to fall-out of Sr^{90} , Cs^{137} , and C^{14} , is discussed and calculated, including geographical distribution, stratosphere residence, radioactive decay, plant uptake, soil leaching, and dilution of the radionuclides with stable elements in nature. Children born in the period 1955 through 1958 will receive the greatest internal dose from Sr^{90} , about 1400 mrem per 30 years. Maximum dose rate was calculated and found to occur in 1961 to 1962. Doses were calculated for the period 1954 through 2000. (auth)

28982 (NP-9368) ESTUDIO DE LA CONTAMINACION Y ABSORCION DEL ^{90}Sr Y ^{137}Cs POR EL PROCHILODUS PLATENSIS (SABALO). INFORME NO. 31. (Study of the Contamination and Absorption of Sr^{90} and Cs^{137} by *Prochilodus Platensis* (Sabalo)). Report No. 31. Leopoldo Jose Anghileri (Argentina. Comision Nacional de Energia Atomica, Buenos Aires). 1960. 14p.

The contamination and absorption of Sr^{90} and Cs^{137} by *Prochilodus lineatus* or *platensis* (sabalo) is studied. A contamination of its "habitat" (Rio de la Plata) would create health problems because of the industrialization along the river and use of the water for purposes related to the biological cycle. The distribution of the elements in various organs and tissues of the fish was determined. The results were compared with those obtained by other workers. (J.S.R.)

28983 STUDIES ON THE UPTAKE OF Sr^{90} FROM ATMOSPHERIC COMPONENTS. A. Klocke and U. Marckwordt (Institut für Nichtparasitäre Pflanzenkrankheiten der Biologischen Bundesanstalt für Land- und Forstwirtschaft, Berlin). Atompraxis, 7: 289-92 (Aug. 1961). (In German)

Cultivated plants grown in a substrate free of Sr^{90} contained, in 1959, the same amounts of Sr^{90} as plants grown in soils which had acquired Sr^{90} from precipitation during the last ten years. Internal and underground plant parts contained relatively little Sr^{90} . About 25% of the activity in green plant parts above ground can be washed away. From these findings it is concluded that in 1959 70 to 90% of the Sr^{90} in plants was taken up from atmospheric components. (tr-auth)

Radiation Effects on Living Tissues

28984 (AMRL-483) EXPERIMENTAL CONDITIONS FOR ACUTE WHOLE-BODY IRRADIATION OF DOGS WITH COBALT 60. R. I. H. Wang and D. E. Davidson, Jr. (Army Medical Research Lab., Fort Knox, Ky.). May 4, 1961. 21p.

Forty healthy, mature mongrel dogs of both sexes weighing 6.0 to 11.0 kg were exposed to whole-body doses of cobalt 60 irradiation at midline tissue doses of 250 r and 500 r (27 to 32 r/min). The dogs were irradiated in either a single cage or a dual cage, the latter permitting the simultaneous irradiation of paired experimental dogs. Clinical examination and blood determinations of hema-

tocrit, hemoglobin, total leukocyte, and differential count were obtained both prior to and following irradiation. Total leukocyte counts fell rapidly in all dogs. Hematocrit and hemoglobin levels decreased following irradiation. Recovery of the blood picture occurred in the dogs which eventually survived. Death of dogs when it occurred, fell between the eighth and twenty-sixth post-irradiation days. The mean survival time decreased as radiation dose was increased. The $\text{LD}_{50/30 \text{ days}}$ for dogs irradiated in the single cage was estimated at 260 r and the $\text{LD}_{100/30 \text{ days}}$ at 325 r. Dual cage irradiation resulted in an $\text{LD}_{50/30 \text{ days}}$ of 335 r and an $\text{LD}_{100/30 \text{ days}}$ of 400 r. The difference in lethality of approximately 75 r between dogs irradiated in the single and dual cages is attributable to the difference in positions occupied by the dogs during irradiation. (auth)

28985 (AMRL-484) REDUCTION OF RADIATION LETHALITY IN DOGS BY CHEMICAL MIXTURE. Richard I. H. Wang and David E. Davidson, Jr. (Army Medical Research Lab., Fort Knox, Ky.). May 5, 1961. 19p.

A total of 68 small dogs were individually exposed to supra-lethal doses of 600 r ($1.8 \times \text{LD}_{100}$) of acute whole-body radiation from a cobalt 60 source. The administration of 4 to 5 mg/kg of para-amino-propiophenone (PAPP) intravenously 30 minutes before, and 225 mg (total dose) of S,β -aminoethylisothiuronium (AET) plus 32.5 mg (total dose) of serotonin intraperitoneally 10 to 15 minutes before irradiation provided 58% survival, whereas the administration of PAPP alone protected only 13%. By supplementing this pre-irradiation chemical treatment with post-irradiation supportive therapy consisting of antibiotics, vitamins, parenteral fluids, and whole-blood transfusions, the survival of the PAPP treated dogs was increased to 63%, while the survival of the dogs receiving the chemical mixture was increased to 82%. Post-irradiation supportive therapy increased the mean survival time of control irradiated dogs by 4 days, but effected survival beyond 30 days in only one case. Pre-treatment with chemical agents seemed to influence favorably the post-irradiation fall in leukocytes, but did not noticeably affect the hematocrit or hemoglobin levels. No deaths occurred as a direct result of the toxicity of the chemical agents; furthermore, the intravenous administration of methylene blue immediately following irradiation rapidly reversed the toxic effects. (auth)

28986 (BNL-5541) KINETICS OF POPULATION OF BONE FORMING CELLS IN THE NORMAL AND IRRADIATED RAT. N. F. Kember (Brookhaven National Lab., Upton, N. Y.). [1961]. 13p.

Radioautograms of the tibia of young rats, previously given tritiated thymidine, were examined to determine the position of cells engaged in the active synthesis of desoxyribonucleic acid. A detailed pattern of cellular labeling is presented. Data are included from preliminary studies on the effects of whole-body irradiation on metabolism in bone. (C.H.)

28987 (NP-10538) EFFECT OF HIGH LEVELS OF IONIZING RADIATION ON ANIMAL TISSUES. Progress Report No. 13, March 1, 1960 to February 28, 1961. Kenneth J. Monty (Johns Hopkins Univ., Baltimore. McCollum-Pratt Inst.). Contract DA-49-007-M.D. 631. 5p.

Progress is reported in studies on pathways leading to the synthesis of the phospholipid plasmalogen, and the nature and physiological significance of the inhibition of the pathways by long-chain aldehydes. Additional information pertinent to the inhibition of pancreatic lipase by aliphatic carbonyl compounds continues to support the postulate that

the inhibition results from a modification of properties of lipid-water interfaces. (C.H.)

28988 (NYO-9341) THE RELATION OF GENOME NUMBER TO RADIOSENSITIVITY. Final Report, September 1, 1954--May 31, 1961. Arnold M. Clark (Delaware Univ., Newark). Contract AT(30-1)-1752. 7p.

A comparison of haploid males and diploid females with respect to their radiosensitivity was made at various stages of embryonic and postembryonic development. Data showed: 1) that the normal aging process is not due to the accumulation of somatic mutations, 2) that the decrease in life span following x irradiation is due to genetic damage, and 3) that the radiation-induced decrease in life span is different from normal aging processes. Oxygen poisoning in insects was studied and compared with the effects of x rays. Studies showed that diploid yeasts are more resistant than haploid yeasts to nitrogen mustards. (M.C.G.)

28989 (ORO-465) REVERSAL OF RADIATION DAMAGE IN ALGAE. Final Scientific Report. Baruch S. Jacobson (Texas Univ., Austin). [nd.]. Contract AT(40-1)-2567. 6p.

Chlamydomonas reinhardtii, a green algal flagellate, was used to study recovery from radiation injury. Recovery seemed to be somewhat inhibited by such antimetabolites as dinitrophenol and chloramphenicol. In view of the temperature dependence of recovery, temperature cycling was studied as a means of achieving synchronous cell division. This treatment did produce a burst of division in which the population rapidly doubled. Radiation lethality seemed to represent the loss of some function of the cell nucleus. Although the recovery process occurred within the first hour after irradiation, lethal radiation damage was expressed only after many hours had elapsed. Most cells entered the multinucleate stages in the normal manner after irradiation, but died, if at all, only after returning to the uninucleate stage. (M.C.G.)

28990 (TID-13393) THE EFFECT OF X-IRRADIATION ON EMBRYONIC HEMATOPOIETIC TISSUE. Final Report, January 15, 1958 to January 14, 1961. L. Keith Wayt (Colorado State Univ., Fort Collins. Coll. of Veterinary Medicine). Contract AT(11-1)-597. 149p.

A total of 581 guinea pigs was used to investigate the effects of x rays on developing hematopoietic tissues. Each pregnant female was anesthetized with sodium pentobarbital and a laparotomy was performed. The embryos in one uterine horn were irradiated once. The embryos in the opposite uterine horn served as non-irradiated controls. After irradiation, all embryos were sacrificed and the hematopoietic tissues were studied. Hematopoiesis in the yolk sac of irradiated embryos did not differ from that in the control embryos regardless of the age at the time of the irradiation. Differences in hematopoiesis in the liver, spleen, and thymus were not found between control embryos and 13-day embryos irradiated with 27, 52, or 78 r, or 15-day embryos irradiated with 50 r, or 16-day embryos irradiated with 100 r. Mild to severe fibrosis of the spleen was found in young animals irradiated with 250 or 300 r as 27-day embryos, and sacrificed at 11, 27, and 28 months after irradiation. The lymphocytes of the thymus were the most sensitive hematopoietic cells. The response of blood-cell precursors in the liver was generally the same as in the spleen. After irradiation, the hematopoietic cells in these organs showed moderate karyorrhexis. The mesenchymal cells of all hematopoietic tissues were more radio-resistant than were the blood cell precursors. In most respects, the effect of irradiation on the embryonic hema-

topoietic tissues and cells was similar to that described in post-natal hematopoietic tissues and cells. (auth)

28991 (TID-13420) THE NATURE OF THE RADIO-SENSITIVE CELLS IN THE DEVELOPING NERVOUS SYSTEM STUDIED WITH TRITIATED THYMIDINE. Samuel P. Hicks, Constance J. D'Amato, and David L. Joftes (New England Deaconess Hospital, Boston and Harvard Univ., Boston. Medical School). [1961]. 6p.

Presented at the Symposium on the Effects of Ionizing Radiation on the Nervous System, International Atomic Energy Agency, Vienna, June 5-9, 1961.

Radiosensitive cells in the developing nervous systems of rats were studied. Experiments using radiation were combined with experiments in which tritiated thymidine (H_3T) was given to the animals. Cells that were replicating their chromosomes in preparation for mitotic division took up H_3T and became radioactively labeled. If an early embryo was irradiated with 200 r one hour after H_3T was given and then killed for study 4 hr later, the labeled cells had moved into the ventricular surface and a few had begun to divide. Large numbers of cells were killed, but very few were labeled. If radiation was given 4 hrs after H_3T to a similar early embryo and it was then killed 4 hr after that, large numbers of labeled cells were found dead. The relative number of dead labeled and unlabeled cells varied with the proliferative pattern in different regions. (M.C.G.)

28992 (TID-13499) GENETIC EFFECTS OF CUMULATIVE IRRADIATION IN RATS. Technical Progress Report, 1960. A. B. Chapman and N. E. Morton (Wisconsin Univ., Madison). Contract AT(11-1)-697. 7p.

Results are reported for preliminary studies of the genetic effects of cumulative x irradiation in rats. No obvious differences were seen in the offspring of male rats irradiated with 450 r and mated with non-irradiated females and the control group. In generation 2, in which both the sire and grandsire were irradiated, the sex ratio of live births was 47.9% as compared to 51.5% for the control group. No data are available for the third generation. (C.H.)

28993 (UR-596) CARDIOPULMONARY CHANGES IN THE DOG FOLLOWING EXPOSURE TO X-RAYS. S. M. Michaelson, B. Schreiner, Jr., C. L. Hansen, Jr., W. J. Quinlan, L. T. Odland, M. Ingram, and J. W. Howland (Rochester, N. Y. Univ. Atomic Energy Project). May 31, 1961. Contract W-7401-eng-49. 16p.

Radiation pneumonitis and pulmonary fibrosis, after therapeutic irradiation over the chest in man and experimentally induced in dogs are described. Pulmonary function in these cases was not extensively investigated. Irradiation of the upper body of beagles with 1000 kvp x rays results in early pulmonary dysfunction. Defective thermal regulation is evident when these animals are subjected to increased environmental temperature or microwave heating. Tachypnea at rest with marked hyperventilation on exercise is noted as early as 7 months following 1750 r MTD (midline tissue dose) and 9 months after 1500 r MTD. As the condition progresses, arterial oxygen saturation is reduced. Death occurs 10 months after 1750 r and 11 months after 1500 r MTD. Necropsy reveals cardiac and pulmonary lesions. (auth)

28994 (UR-597) PATHOLOGIC EFFECTS OF IONIZED STRONTIUM-90 IN RATS AND MONKEYS. George W. Casarett, Lawrence W. Tuttle, and Robert C. Baxter (Rochester, N. Y. Univ. Atomic Energy Project). June 12, 1961. Contract W-7401-eng-49. 16p.

Seven young adult Rhesus monkeys were given Sr^{90} solution orally. Of three which imbibed 500 μc , the first died in 35 months of radiation effects on hemopoietic tissues and parasitism, with a retained body burden of 34 μc , having received about 4500 rads to the skeleton. The second died of monocytic leukemia (variant of lymphatic leukemia) in 48 months, with a retained body burden of 45 μc and a skeletal dose of 4300 rads. The third monkey is alive and well after 80 months, with a body burden of 22 μc and a skeletal dose to date of about 2000 rads. Four of the monkeys imbibed 1000 μc Sr^{90} . The first died of pancytopenia in 4 months, with a retained body burden of 200 μc and a skeletal dose of 4500 rads. The second died of pancytopenia and parasitism in 18 months, with 116 μc retained and a skeletal dose of 9100 rads. The third died of chondrosarcoma after 36 months, with a retained body burden of 76 μc and a skeletal dose of 9500 rads. The fourth died after 45 months of osteosarcoma, with a body burden of 33 μc and a skeletal dose of 4700 rads. Rats 425 days old given 330 μc Sr^{90} orally in 10 days showed slight damage of bone marrow and premature involution of the cartilage plate in zones of endochondral ossification. Five months after the last dose these rats had retained 1 μc in the skeleton. The average accumulated dose to the skeleton at this time was approximately 300 to 600 rads in male and female rats, respectively. Rats 346 days old given 650 μc in 10 days showed somewhat greater damage of marrow and of the cartilage plate, and increased incidence of soft-tissue malignancies, including leukemia and facial skin carcinomas. These rats retained 2 μc at 5 months after the last dose and had accumulated approximately 700 to 1100 rads. Rats 117 days old given 790 μc in 30 days showed marked damage of marrow and bone growth centers, high incidence of osteosarcoma (27.5%), increase in incidence of certain soft-tissue malignancies, including leukemia (6.25%) and facial skin carcinoma (11.25%), and life span shortening (34%). The skeletons of these rats had received radiation doses of from 3700 to 5200 rads and retained 11 μc at 5 months after ingestion. Rats 40 days old given 464 μc in 10 days showed severe damage of marrow and bone growth centers, high incidence of osteosarcoma (17.5%), and marked life shortening (80%). These rats retained 33 μc five months after dosing and skeletal doses at this time were estimated to have been 19000 to 25000 rads. (auth)

28995 (UR-598) CONCEPT AND CRITERIA OF RADIOLOGIC AGING. George W. Casarett (Rochester, N. Y. Univ. Atomic Energy Project). June 16, 1961. Contract W-7401-eng-49. 28p.

Critical general comparison of various manifestations of aging and late radiation effects strongly suggests premature aging as an effect of irradiation, on a generalized or localized basis. Presented is an hypothesis of the process of radiologic aging at the tissue level, based on histopathologic studies of the development of manifestations of aging and of late radiation effects in tissues prior to disease development. This hypothesis maintains that non-specific injury of endothelium of fine vasculature by direct or indirect mechanisms leads to increase in density and amount of collagenous substance interstitially and in sub-endothelial regions of arterioles. These changes constitute a temporal advancement in the increase of the histohematic barrier and in the development of arteriolo-capillary fibrosis, which are progressive processes in normal aging. Eventually these processes cause progressive reduction in number of dependent parenchymal cells due to relative hypoxia and malnutrition. Secondary to parenchymal loss

is a process of replacement fibrosis and reduction of fine vasculature, with consequent further increase in histohematic barrier and arteriolo-capillary fibrosis. Concomitant with parenchymal loss is progressive reduction of functional reserve capacities and a corresponding progressive increase in susceptibility of tissues to trauma, stress, and disease. (auth)

28996 (JPRS-8727) THE EFFECT OF BACTERICIDAL IRRADIATION ON THE VIRULENCE OF MICRO-ORGANISMS. R. S. Mostova. Translated from Sbornik Trudov, Inst. Rad. Gigieny, 150-7(1959). 6p.

Studies were made of the effects of ultraviolet radiation from bactericidal lamps on bacteria in air. When samplings of air were taken for different periods of time from the beginning of exposure, the greatest drop in the number of microbes was noticed during the first 30 min, after which the destruction of the bacteria slowed down. Complete sterilization of the air was not achieved even after 5 hr of irradiation. To study the effect of bactericidal irradiation on the virulence of bacteria, cultures of pathogenic strains of *Bacillus coli* and *staphylococcus* were irradiated and later the irradiated and control strains were studied by administering them to mice and rabbits. Results indicated that the irradiation undoubtedly weakens the virulence of the bacteria, but a rather prolonged time is required for this. (M.C.G.)

28997 (JPRS-9663(p.12-21)) LIVER TUMORS DEVELOPING UNDER THE INFLUENCE OF CERIU-144. V. N. Strel'tsova. Translated from Arkh. Patol., 23: No. 3, 9-16(1961).

A description is presented of tumors of the liver developing under the influence of Ce^{144} in 17 out of 378 rats surviving more than 200 days after a single intraperitoneal injection of 0.25 to 2.14 μc per gram of this isotope. In a series of experiments with the parenteral administration of 0.005, 0.01, 0.025, and 0.06 μc per gram of Ce^{144} , a reorganization of the vascular system, connective tissue stroma, and liver parenchyma were observed. In the study of the liver changes preceding the appearance of tumors it was established that all neoplasms of this organ appear against a background of cirrhosis. The incidence of occurrence of the neoplasms of the liver within the limits of the quantities of isotope investigated was proportional to the quantity of Ce^{144} administered. The time of their occurrence was inversely proportional to the dose. (M.C.G.)

28998 (JPRS-9663(p.30-7)) INVESTIGATION OF THE ROLE OF THE REFLEX COMPONENT IN THE BODY'S REACTION TO THE EFFECT OF EXTERNAL IONIZING RADIATION. A. G. Sverdlov. Translated from Arkh. Patol., 23: No. 3, 21-5(1961).

An investigation was made of the role of reflex influences in the blood changes in irradiation. In the experiments performed on rabbits, the ear was irradiated with x rays. During the 3 to 5 days before irradiation and in the subsequent 20 to 25 days, an investigation was made of the peripheral blood. Results from the majority of animals showed that a day or two after irradiation a reduction of the total white blood count, lymphocyte count, and blood coagulation occurred. The observations showed that exclusion of nerve connections in the irradiated field is associated with changes in the blood reaction to irradiation. After irradiation against the background of novocain block, the number of pathological formed elements of the blood was definitely less than after ordinary local irradiation. Data indicated that the degree of pathological blood changes after local irradiation depend a great deal on the reflex

influences from the tissues irradiated. The injections of thorazine showed no effects on the development of radiation injury. (M.C.G.)

28999 (JPRS-9663(p.38-49)) ACUTE RADIATION NECROSIS OF THE SKIN. L. A. Afrikanova. Translated from *Ark. Patol.*, 23: No. 3, 26-33(1961).

Radiation in large doses was found to produce acute radiation necrosis in the skin. An attempt was made at experimental elucidation of the significance of injury to the innervation mechanisms in the development and outcomes of resulting chronic indolent ulcers along with a detailed study of the morphologic characteristics of acute radiation necrosis of the skin. The experiments were performed on cats, rats, and white mice. Acute radiation necrosis was caused by irradiation of the section of the skin with soft x rays in doses of 5,000 r. Various types of intervention into the course of the experiment had no effect on the course of the destructive phase. In all cases the process in the skin was completed with acute radiation necrosis in the second to third week of the lesion. The healing process was characterized by the absence of normal interrelationships between the various tissue components of the scar tissue. Complete spontaneous healing of the skin defect did not usually occur. The development of degenerative changes in the neurons providing the sensory innervation of the area of the lesion in the corresponding nerve centers was chiefly responsible for the disturbances in the course of the processes of repair which occur in radiation injuries. (M.C.G.)

29000 (JPRS-9718) THE EFFECT OF VARIOUS AGENTS ON RADIATION INJURIES. Translated from *Trudy Inst. Biol., Akad. Nauk S.S.S.R., Ural.' Filial*, No. 12, 46-75; [76-92]; 93-118(Dec. 1960). 146p.

Included are three articles concerned with the effects of various substances on radiation effects in mice, the effects of cysteine and other sulfur-containing compounds on radiation effects in animals and plants, and the effects of yeast extracts on the mortality of irradiated mice and pea seedlings. (B.O.G.)

29001 (JPRS-9718(p.1-57)) THE EFFECT OF VARIOUS SUBSTANCES ADMINISTERED TO MICE ON THE EFFECT OF RADIATION. N. V. Luchnik. Translated from *Trudy Inst. Biol., Akad. Nauk S.S.S.R., Ural.' Filial*, No. 12, 46-75(Dec. 1960).

Experiments were conducted in a comparative study of the effects of antiradiation agents on the theory of peaks in the mortality rate of mice and rats. The results are discussed in terms of the first mortality peak as a function of radiation dose and peculiarities of the experimental animal, the influence of the agents on the mortality of mice irradiated with a 1000 r dose, and experiments with small doses. The individual agents were found to act selectively on the three peaks, appearing at 3.5, 7, and 9.5 days, which indicates that the mortality peaks are a reflection of the final causes of death of the irradiated animals. (B.O.G.)

29002 (JPRS-9718(p.58-94)) THE EFFECT OF CYSTEINE AND CERTAIN OTHER SULFUR-CONTAINING SUBSTANCES ON THE EFFECT OF IRRADIATION OF ANIMALS AND PLANTS. N. V. Luchnik and E. (Ye.) A. Timofeeva-Resovskaya (Timofeyeva-Resovskaya). Translated from *Trudy Inst. Biol., Akad. Nauk S.S.S.R., Ural.' Filial*, No. 12, [76-92] (Dec. 1960).

A comparison of the protective effects of cysteine and other sulfur-containing compounds shows that cysteine surpasses the other materials tested. The administration of cysteine prior to irradiation in moderate doses in-

creases the number of surviving mice and rats, while in higher doses it increases the mean life span. The administration after irradiation produces no effect. Cysteine does not influence the initial loss of weight or the number of formed elements in the peripheral blood in rats, but it accelerates the restoration of these indices to normal. In peas the protective effect of cysteine is approx proportional to the logarithm of its concentration. The maximal protective effect is achieved with a two-hour soaking of the sprouts. To obtain a protective effect, it is necessary that the cysteine be present in the tissues at the time of irradiation. (B.O.G.)

29003 (JPRS-9718(p.95-146)) THE EFFECT OF YEAST EXTRACTS ON THE MORTALITY OF IRRADIATED MICE AND PEA SEEDLINGS. N. V. Luchnik. Translated from *Trudy Inst. Biol., Akad. Nauk S.S.S.R., Ural.' Filial*, No. 12, 93-118(Dec. 1960).

Cell-free yeast extracts, used after irradiation, were found to reduce the mortality of mice, the suppression of growth of peas, and the number of abnormal mitoses in their cells. The extracts were nontoxic and possess antiradiation properties over a wide range of doses, especially wide for cytological effects. Keeping the cells, prior to preparation of extracts, under unfavorable conditions for their existence, such as low temperature, drying, and irradiation, imparts the antiradiation to them, which is connected with the presence of ribonucleic acid in the cells. (B.O.G.)

29004 (JPRS-9971) EFFECT OF X-RAY IRRADIATION ON THE MEMBRANE POTENTIAL AND CONCENTRATION OF SODIUM AND POTASSIUM IN FROG MUSCLE FIBERS. V. I. Bogomolets. Translated from *Fiziol. Zhur., Akad. Nauk Ukr. R.S.R.*, 7: 214-19(Mar.-Apr. 1961). 13p.

The effects of 60 to 300 krad x rays on the sartorius thigh muscles of the frog were studied by measurements of the membrane potential and the K and Na concentrations in the muscle fibers. The results indicate that the membrane potential is reduced immediately after x-irradiation and thereafter remains relatively constant, and that the muscle loses K and acquires Na under x-irradiation. The radiation effects are ascribed to a relaxation of the membrane and consequent equilibration of ions on the membrane sides. The results are compared with previous findings of other workers. (D.L.C.)

29005 (NP-tr-742) A STUDY OF THE BACTERICIDAL MECHANISM OF Co-60 RADIATION. T. Akimoto. Translated by S. G. Brickley for U.K.A.E.A., Atomic Energy Research Establishment, Harwell, Berks, Eng., from *Radioisotopes* (Tokyo), 9: No. 1, 6-16(1960). 29p. (Includes original, 6p.).

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 15, abstract no. 22141.

29006 A POSSIBLE INTERPRETATION OF THE CARCINOGENIC EFFECT OF RADIATIONS AND CARCINOGENIC HYDROCARBONS ON THE BASIS OF THE ELECTRONIC STRUCTURE OF DEOXYRIBONUCLEIC ACID. T. A. Hoffmann (Research Inst. for Telecommunication, Budapest) and J. Ladik. *Acta Phys. Acad. Sci. Hung.*, 13: 103-11(1961). (In English)

It is suggested that the primary role in the mechanism of carcinogenesis should be attributed to desoxyribonucleic acid (DNA) rather than to protein. Analysis of the position of the energy bands shows that the DNA molecule can be made conductive by the application of radiation of suitable energy. By realizing that at the ends of the DNA molecule radiation or carcinogen may produce excess charge, a relation can be established between the initiation of elec-

tronic conduction and that of carcinogenesis. It is shown that it is probable that the polarization of the chain ends of DNA, induced by radiation or carcinogen, may start the mechanism of molecule duplication without any other effect on the chain ends. Two possibilities are suggested of how this mechanism may lead to the formation of a macroscopic tumor. (J.S.R.)

29007 GENETIC HAZARDS OF RADIATION TO MAN. PART II. Paul De Bellefeuille (Univ. of Ottawa). *Acta Radiol.*, 56: 145-59 (Aug. 1961). (In English)

From various experimental and clinical data on the incidence and the genetic portion of congenital anomalies and on their induction by ionizing radiation an attempt was made to predict the magnitude of the increase in human reproductive wastage in the first generation, which would lie in the neighborhood of +0.01 per roentgen (gonad dose). The implications of this parameter are discussed in connection with the risks to which human populations are, or may be, exposed through clinical use of roentgen rays, fall-out from nuclear weapon tests, and the possible use of such weapons in warfare. (auth)

29008 BLOOD-MARROW MIXTURES IN IRRADIATED MICE. Effect of Blood Injection on Bone Marrow Transplantation in Lethally Irradiated Mice. Joan Wright Goodman and C. C. Congdon (Oak Ridge National Lab., Tenn.). *A.M.A. Arch. Pathol.*, 72: 18-26 (July 1961).

Evidence has been presented that a radiosensitive, immunologically competent cell is present in the blood of normal mice. When injected into an irradiated homologous bone marrow-treated mouse, this cell causes or contributes to the death of the recipient. If isologous blood cells are used, death results from rejection of the grafted homologous marrow. When homologous blood is given, the marrow graft persists until death of the animal from an exaggerated secondary disease syndrome. Results of parent- F_1 experiments also are consistent with the existence of an immunologically competent cell in the blood, but some do not agree with the usual parent- F_1 transplantation theories. The effective cell in the peripheral blood is presumed to be the monocyte or large lymphocyte. It may originate in the germinal centers of organized lymphatic tissues, although other sources cannot be completely ruled out. The presence of immunologically active cells from blood contaminating the bone marrow preparations in experiments with large animals may explain some of the difficulties encountered in getting recovery from lethal irradiation in these species, including man. (auth)

29009 THE EFFECTS OF CARDIAC IRRADIATION UPON THE NORMAL CANINE HEART. Elliot Senderoff, Mamoru Kaneko, A. Robert Beck, and Ivan D. Baronofsky (Mount Sinai Hospital, New York). *Am. J. Roentgenol., Radium Therapy Nuclear Med.*, 86: 740-51 (Oct. 1961).

Ligation of the anterior descending coronary artery was performed on 66 dogs following varying doses of cardiac irradiation at varying intervals of time. A pathologic analysis of the hearts by means of injection and corrosion studies, and gross and microscopic examination was carried out. Thirty control dogs, similarly ligated but not irradiated, were studied in the same manner. Nineteen irradiated animals, dying at varying intervals during and after radiation therapy (but prior to coronary ligation), were also studied. The irradiated animals presented functioning intercoronary anastomotic channels at the time of coronary ligation. A spared area of normal muscle was seen in the subepicardium overlying the area of infarction in the irradiated hearts, but was not observed in the nonirradiated control hearts. Irradiated hearts healed

faster than equivalent control hearts following myocardial infarction, as healing could occur from the spared area of normal muscle. The effects of varying doses of cardiac irradiation upon the heart, lungs, bone marrow, hemogram, and mediastinal tissues were studied up to one year following irradiation. Evidence of focal radiation induced pleural and marrow changes directly under the field of irradiation was observed at some doses. The significance of these findings is discussed. (auth)

29010 SLOWING DOWN OF THE EVOLUTION OF SKIN RADIOLESIONS FOLLOWING A POST-TREATMENT WITH HYALURONIDASE. J. Loiseleur (Institut Pasteur, Paris, France). *Ann. inst. Pasteur*, 101: 284-8 (Aug. 1961). (In French)

Skin radiosensitivity is linked to the activity of connective tissue. It is decreased by a preventive treatment with an anti-hyaluronidase serum. After irradiation, the direct injection of the enzyme delays the appearance of the radiolesions. (auth)

29011 EFFECTS OF DIETARY HEXOSES ON CHANGES INDUCED IN HEPATIC ENZYME ACTIVITIES OF THE RAT BY A LETHAL DOSE OF X-RAYS. Walter M. Fitch, I. L. Chaikoff, and R. Hill (Univ. of California, Berkeley). *Arch. Biochem. Biophys.*, 94: 387-91 (Sept. 1961).

The effects of a lethal dose of whole-body x irradiation (900 r) on the activities of 15 hepatic enzymes were studied. For one week before they were subjected to the x irradiation the rats were fed synthetic diets containing either 60% glucose or 60% fructose. They were deprived of food for 24 hr between the time they were x irradiated and the time they were killed for study of their hepatic enzymes. In only a few instances did hepatic enzyme activities of the x irradiated rats differ significantly from those of nonirradiated, nonfasted rats. Fifty % of the enzyme activities measured in the irradiated rats differed significantly from those in fasted, nonirradiated control rats. The prefeeding of fructose—in contrast to that of glucose—had a selective action in maintenance of elevated levels of hepatic enzyme activities in the irradiated rats. It was concluded that x irradiation causes the animal to lose its ability to produce the normal adaptive response in hepatic enzymes to a 24-hr fast. (auth)

29012 THE COMPARABILITY OF RADIO-PHYSIOLOGICAL STUDIES IN HIGHER PLANTS. R. Biebl and T. V. Kreybig (Universität, Vienna and Universität, Tübingen, Ger.). *Atompraxis*, 7: 284-8 (Aug. 1961). (In German)

Certain terms are examined as used in radiological research in botany, the various reference systems for radiation resistance, and the objective conditions for irradiation experiments, with illustrative examples. It is pointed out that during ontogenetic development, radiation resistance changes in an approximately constant manner for any given species. The extreme variations in radiation resistance found in various species can be compared only after a more exact determination of the objective conditions and after a more precise definition of the irradiation conditions. This is also true for studies of radiation reactions. (tr-auth)

29013 TOTAL BODY X-IRRADIATION IN CARPS. P. De Franciscis, G. De Bella, and V. Muto (Università, Naples). *Atompraxis*, 7: 292-4 (Aug. 1961). (In English)

A total of 350 carps was submitted to a total body x-ray dosage of 1028, 4788, 9576, 19132, and 38600 r generated by a 180 to 250 kv machine. The post-irradiation injection with carp spleen homogenate in fish treated with 9576 and 38600 r was able to delay the onset of death. (tr-auth)

29014 THE INHIBITION OF DNA SYNTHESIS BY CALF-THYMUS POLYMERASE BY X-IRRADIATION OF THE PRIMER DNA. K. A. Stacey (Yale Univ., New Haven). *Biochem. Biophys. Research Commun.*, 5: 486-90 (Sept. 18, 1961).

Studies were made to determine whether or not DNA damaged by x irradiation may be easily replicated by the DNA synthetic mechanism. It was found that the synthesis of new material is strongly inhibited by large doses of x rays, and that within the experimental error, there is no great difference in the amounts of incorporation of d-TMP and d-CMP at any dose level that was examined. The results emphasize that the system used for assaying the effects of irradiation may greatly modify the results obtained. (P.C.H.)

29015 THE CANCERICIDAL EFFECTS OF X IRRADIATION AT BODY TEMPERATURE BELOW 10°C. Peter J. Connaughton and F. John Lewis (Northwestern Univ., Chicago). *Cancer*, 14: 1060-2 (Sept.-Oct. 1961).

In rats inoculated with Lewis lymphoma, there was no retardation of tumor growth when the rat was subjected to body temperatures below 10°C for 30 minutes or when given 400 r of whole-body irradiation during this hypothermic period. When 1000 r of whole-body irradiation was given during the hypothermic period, there was a significant decrease in tumor size compared to that for the controls, but the decrease was not greater than that observed with 400 r of total body irradiation at normal body temperatures. Consequently, the inoculated Lewis lymphoma was protected from irradiation by hypothermia to the same degree as the total animal, and no selective cancericidal effect of irradiation administered during hypothermia was demonstrated. (auth)

29016 AN EVALUATION OF EFFECTS OF MASS SELECTION AND SEED IRRADIATION WITH THERMAL NEUTRONS ON YIELD OF CORN. C. O. Gardner (Univ. of Nebraska, Lincoln). *Crop Sci.*, 1: 241-5 (July-Aug., 1961).

Although the irradiation treatment was detrimental to yield, the irradiated strain significantly outyielded the original variety and yielded only slightly less than the mass-selected control strain after four generations of selection. It is doubtful that irradiation of an already genetically variable population will prove to be particularly valuable as a breeding procedure; yet it is too early to draw definite conclusions. Additional generations of selection are needed. Because of its simplicity and apparent effectiveness, the use of mass selection of individual plants is suggested as a possible method of yield improvement in populations of corn segregating for genes controlling yield. Where the advantages of hybrids other than yield are desired, mass selection is suggested as a possible means of increasing the frequency of favorable genes in segregating populations prior to inbreeding. If over-dominance exists at any locus, mass selection will not be successful in altering gene frequency for that locus after an equilibrium point is reached. Some possible explanations are advanced for the apparent lack of success of early corn breeders using mass-selection and ear-to-row breeding techniques. (P.C.H.)

29017 THE EFFECT OF A COMBINED TREATMENT OF STREPTOMYCES AUREOFACIENS WITH ULTRAVIOLET RAYS AND X-RAYS AS A FUNCTION OF THE ORDER OF IRRADIATION. S. Yu. Gol'dat (All-Union Scientific-Research Inst. of Antibiotics, Ministry of Health, USSR). *Doklady Akad. Nauk S.S.S.R.*, 139: 219-22 (July 1, 1961). (In Russian)

Streptomyces aureofaciens LS-B-16 spores were irradiated with x rays and with ultraviolet rays (80% of the

rays had a $\lambda = 2537 \text{ \AA}$). In all experiments one type of irradiation was followed by the other at intervals of not over 10 min. It was found that delivery of the x ray dose (12,000 and 36,000 r) in fractions over time intervals of not over 10 minutes increased the survival of the spores by a factor of 2 to 5 as compared with the lethal effect obtained on delivery of the total dose at one time. The effect of fractionating the ultraviolet dose was even more marked. The survival increased by a factor of 6.3 on administering a total dose of 4000 erg/mm² in two portions, and by a factor of 44 on delivering the dose in three portions. If the spores are treated with 36,000 r of x rays followed by 4000 ergs/mm² of ultraviolet rays, the survival was $1.6 \times 10^{-5}\%$. The survival increased by a factor of 27.5 on delivering the same dose in two equal portions, and by a factor of 187 on delivering the same dose in three equal portions. However, if the dose of ultraviolet rays is followed by the dose of x rays, no increase in survival was observed on administering the same total dose in smaller equal portions. Thus, ultraviolet rays protect the cell from the secondary effects of an x irradiation. (TTT)

29018 EFFECT OF X-IRRADIATION ON TRIGLYCERIDE METABOLISM OF THE RABBIT. N. R. Di Luzio, E. E. Elka, N. R. Seidenverg, and C. Entenman (Univ. of Tennessee, Memphis and U. S. Naval Radiological Defense Lab., San Francisco). *Experientia*, 17: 321-2 (1961). (In English)

After lethal x irradiation, an increase of the triglyceride, but no change of the free fatty acids, was found in the rabbit plasma. A functional trial with ¹³¹I-labeled triolein led to no inhibition of the hepatic accumulation of this material in the irradiated animals. The results therefore indicate that no perturbation of the fat transfer from the plasma is caused by the x irradiation, but that the lipemia takes place through abnormal chylomicra. (tr-auth)

29019 ULTRAVIOLET MICROBEAM IRRADIATION OF THE NUCLEOLI OF LIVING CELLS. P. O'B. Montgomery and L. L. Hundley (Southwestern Medical School of the Univ. of Texas, Dallas). *Exptl. Cell Research*, 24: 1-5 (June 1961). (In English)

Ultraviolet microbeam irradiation of the nucleoli of living cells was continuously carried out for periods up to 12 hours. The procedure results in a marked loss of the ultraviolet absorbing material from the nucleolus in approximately 4 to 6 hours. For the next 6 or 7 hours no detectable change occurred in the ultraviolet absorption image of the cell or in the visible light image of the cell, and the microscopically detectable cell functions and types of motion continued in an unaltered fashion. (auth)

29020 EFFECTS OF LOCALIZED UV IRRADIATION ON INCORPORATION OF ADENINE-8-C¹⁴, URIDINE-H³, AND DL-METHIONINE-S³⁵ INTO PROTEINS OF ACETABULARIA MEDITERRANEA. M. Olszewska, F. de Vitry, and J. Brachet (Université libre, Brussels). *Exptl. Cell Research*, 24: 58-63 (June 1961). (In French)

The effects of localized uv radiation (tip or rhizoid) on cap formation and incorporation of labeled precursors (adenine-8-C¹⁴, uridine-H³, and DL-methionine-S³⁵) into RNA and proteins were followed in *Acetabularia*. It was found that the three precursors studied are incorporated first in the nucleus and that they are then distributed according to a decreasing apico-basal gradient in normal algae. After uv irradiation of the tip, cap production and incorporation of the precursors in the apical region are markedly decreased. Irradiation of the rhizoid has less effect on cap formation and markedly reduces the incor-

poration, but without modifying the apico-basal gradient. It is concluded that the nucleus controls the synthesis of RNA and sulfur-containing proteins, which accumulate in the apical part of the alga where they play an important role in morphogenesis. (auth)

29021 A POSTIRRADIATION OXYGEN EFFECT IN BACTERIAL SPORES AND ITS DEPENDENCE ON WATER CONTENT. A. Tallentire and D. J. G. Davies (Univ. of Manchester, Eng.). Exptl. Cell Research, 24: 148-50 (June 1961). (In English)

Experiments are described in which damage, induced in spores by irradiating in oxygen, increases after irradiation. Data are presented which show that water affects oxygen dependent mechanisms which may result in lethal damage in resting cells. A rapid fall is shown in the level of survivors during the first 24 hr, followed by a slower fall during the remainder of the observed storage period. In contrast, the survival levels of spores in secondary dried powder irradiated and stored under reduced pressure does not decrease with postirradiation storage. The finding of an increase in radiation-induced damage in secondary dried spores stored in oxygen compared with none following irradiation and storage under reduced pressure, points to the fact that the postirradiation effect is associated with oxygen dependent reactions occurring in the physiologically inactive dry spore. Although the mechanisms are not known, it is shown that some of the reactions are affected by water present in the spore during or after irradiation. A comparison of dose survival curves, constructed from the data presented yields for the oxygen enhancement ratio which increase according to the length of postirradiation storage. (P.C.H.)

29022 DNA LABELLING IN BONE MARROW CELLS OF X-IRRADIATED MICE RECEIVING HOMOLOGOUS ^{32}P -LYMPHOCYTES. M. Hill (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Exptl. Cell Research, 24: 405-13 (Aug. 1961).

Labelled lymphocytes obtained from thymuses of donor mice injected with inorganic P^{32} were given to recipient mice subjected to x-irradiation with 800 r 24 hr previously. The DNA labelling of recipients' bone marrow cells was studied in Feulgen-stained autoradiographs 2 and 6 hrs after the treatment. The highest frequency of labelling was found in granulocytes which were followed in a descending order by mononuclear cells, reticular cells, megakaryocytes, and myelocytes. Mitotic figures were not labelled. The label was localized either evenly all over the nucleus or unevenly in certain areas of the nucleus. It is suggested that the recipients' bone marrow cells were labelled by taking up DNA- P^{32} from disintegrating donor lymphocytes and by incorporating it into their nuclei. (auth)

29023 RESEARCH ON THE EFFECTS OF RADIATION ON "NICOTIANA." III. ASPECTS OF THE RADIORESISTANCE OF THE GENUS NICOTIANA. G. T. Scarascia (C.N.R.N., Rome). Genet. agrar., 8: 123-55 (1960). (CNEN-75). (In Italian)

The presence of species at different levels of ploidy in the genus *Nicotiana* was utilized to study correlations between polyploidy and radioresistance. Seeds were irradiated with x rays (doses from 2,000 to 64,000 r) or with fast neutrons (doses from 110 to 6,250 rep). Germination chromosomal aberrations and LD_{50} at the 4 to 6 leave stage were the events considered. The experiment showed that the diploids are more radiosensitive than the polyploids, among them *N. rustica* is more resistant than *N. tabacum*. Among the cultivators of this species V. bright, as pre-

viously observed, confirms its higher radiosensitivity. (auth)

29024 USE OF IONIZING RADIATIONS IN THE GENETIC IMPROVEMENT OF ITALIAN WHEATS. S. Avanzi (C.N.R.N., Rome), F. D-Amato, B. Donini, G. T. Scarascia. Genet. agrar., 12: 231-50 (1960). (CNEN-46). (In Italian)

Observations on the R_1 and R_2 effects of x rays and thermal neutrons on the durum wheat Cappelli and the bread wheat Brescia are reported. New data concerning the R_3 analysis are also presented. The R_3 analysis showed that: a) most of the vital and fertile chlorophyll mutants isolated in R_2 bred true; b) only 24% of the chlorophyll heterozygotes tested showed a 3:1 ratio, the remaining ones giving a sometimes pronounced deficit of recessives; c) a proportion of progenies which did not segregate in R_2 (15% and 25% in Cappelli and Brescia, respectively) first segregated in R_3 . This last observation calls attention on the need for extending mutation screening to R_3 also. (auth)

29025 INACTIVATION AND MUTATIONS IN MYCOBACTERIUM AVIUM BY DECAY OF INCORPORATED RADIOACTIVE PHOSPHORUS. Michio Tsukamura (Obuso National Sanatorium, Obu, Japan). Genetics, 46: 911-24 (Aug. 1961).

Inactivation and mutation occurred in *Mycobacterium* Jucho by decay of incorporated radioactive phosphorus (P^{32}) under the conditions in which cells labeled with P^{32} were stored in freezing state during the progress of P^{32} decay, and the existence of any selective process of marker mutants could be excluded. Relationships between the inactivation and mutations and the intracellular distribution of P^{32} were studied. Fractionation of radioactive cells was also performed. Inactivation of cells was much more markedly affected by the amount of P^{32} in the DNA fraction than by the amount of total radioactivity of cells that parallels the amount of beta-ray irradiation. Inactivation curves, survival curves plotted as a function of the amount of P^{32} decay, tended to be exponential, if the DNA fraction was labeled heavily by P^{32} . It is suggested that beta-ray irradiation is not responsible for inactivation of bacterial cells and decay of P^{32} in the DNA fraction, but that change of P^{32} into S^{32} in DNA structure is mainly responsible for it. If cells were labeled by P^{32} representing a relatively low content of P^{32} in the DNA fraction, inactivation of cells occurred showing decay-survival curves of a multihit type. Thus, it is also suggested that inactivation of cells may occur also by decay of P^{32} in multiloci outside of the DNA. Mutation frequency to isoniazid resistance was rapidly increased with progress of P^{32} decay, while mutation frequency to streptomycin resistance was not increased or only slightly increased. Thus, a marked discrepancy between these two mutations was observed. Mechanism of this discrepancy was discussed. The incidence of mutation (to isoniazid resistance) did not parallel the amount of total radioactivity of cells that corresponded to the amount of beta-ray irradiation. The induced mutation was increased roughly in accordance with the progress of P^{32} decay. It is conceivable that the induced mutation also occurs by decay of incorporated P^{32} . (auth)

29026 SOMATIC FLOWER-COLOR VARIATIONS AND MORPHOLOGICAL CHANGES INDUCED BY C^{14} IN THE SNAPDRAGON, ANTIRRHINUM MAJUS. Norman D. Williams and N. J. Scully (Argonne National Lab., Ill.). Genetics, 46: 959-69 (Aug. 1961).

The genetic and morphological effects of radiocarbon when incorporated into plants of the common snapdragon

were investigated. Plants of an F_1 hybrid heterozygous for flower color and plants of the variety Windmillers Lilac were exposed to atmospheres containing carbon dioxide enriched with $C^{14}O_2$. The estimated radiation dosages were 0.69, 3.5, 25.8, and 160 rep per day for plants grown in air-phase specific activities of 4, 25, 150, and 900 μ c per gram carbon, respectively. The frequency of somatic mutations increased from 0.61 mutant areas per flower in controls, to 1.24, 1.53, 5.66, and 28.06 mutant areas per flower at air-phase activities of 4, 25, 150, and 900 μ c per gram carbon, respectively. The relationship between air-phase specific activity and frequency of mutant areas appeared to be linear at air-phase specific activities from 25 to 900 μ c per gram carbon; the efficiency of radiocarbon treatment was greatest at 4 μ c per gram carbon. Only two phenotypic classes of mutant areas, pink and white, were classified accurately. Neither the pink nor the white areas were attributed to mutation at specific loci. On the average, pink mutations were observed 7.5 times as frequently as white. No morphological changes in plants of the F_1 hybrid and Windmillers Lilac were observed at the three lower air-phase specific activities. Plants exposed to the 900 μ c per gram carbon air-phase activity exhibited reduced lateral branching and flower production, increases in leaf thickness, stem diameter, plant height, abnormalities in flowers, and dichotomous branching of the main stem. Comparisons with other results indicate that radiocarbon treatment was slightly more effective than equivalent amounts of ionization from chronic gamma irradiation in producing certain morphological changes. Radiocarbon and chronic gamma irradiation were not shown to differ in effect in the induction of somatic flower color mutations in snapdragons. (auth)

29027 RADIATION ANALYSIS OF A LECANOID GENETIC SYSTEM. Spencer W. Brown and Walter A. Nelson-Rees (Univ. of California, Berkeley). *Genetics*, 46: 983-1007 (Aug. 1961).

In the lecanoid chromosomal system, as exemplified by the mealy bug, *Planococcus citri* (Risso), one chromosome set becomes heterochromatic during embryogeny of the male and is maintained as such during development. At spermatogenesis, the first division is equational for both the euchromatic and heterochromatic chromosomes which are segregated from each other in the second; only the euchromatic derivatives form sperm. After paternal irradiation, the induced aberrations appear in the heterochromatic set of the male embryos while they occur in the euchromatic set after maternal treatment. After paternal irradiation of doses up to 30000 rep, dominant lethality is induced in daughters but not in sons. There is thus a clear picture of the failure of damage to the heterochromatic set to produce a detectable genetic effect. These results do not rule out a secondary genetic or physiological function of the heterochromatic set. No breakage-fusion-bridge cycles, which would complicate the results whether the heterochromatic set were inert or not, were observed in the cytological studies after low-dosage treatments. After maternal treatment, both sexes diminish with increasing dosage but the results are complicated by the effect of maternal age on the sequence in which the two sexes of offspring occur during oviposition (sexual dichronism) as well as on total progeny. At high-dosage paternal treatments, 60, 90, and 120,000 rep, the number of sons is drastically reduced while the number of daughters is about 40% of the controls. (P.C.H.)

29028 EFFECT OF X-IRRADIATION ON DEVELOPING PROTEIN-SYNTHESIZING SYSTEMS. Ole A. Schjeide,

Nancy Ragan, and Sue Simons (Univ. of California, Los Angeles). *Growth*, 25: 157-64 (June 1961).

No depressing effect of 558 rads of x radiation on the developing synthetic mechanisms for estrogen-induced serum X_1 -phosphoprotein was detected, despite concerted efforts to select optimum timing and sequence with respect to irradiation and estrogen treatment. Possible reasons for the lack of sensitivity of this protein synthesis system, as compared to the serum albumin and dense (alpha) lipoprotein mechanisms, are discussed. (auth)

29029 USE OF TOTAL-BODY RADIATION IN THE TREATMENT OF FAR-ADVANCED MALIGNANCIES. E. Richard King (National Naval Medical Center, Bethesda, Md.). *J. Am. Med. Assoc.*, 177: 610-13 (Sept. 2, 1961).

Total-body radiation was used to treat 17 patients with far-advanced cancer. Good palliative responses were achieved by 6 patients with small repeated doses. The results of 11 patients treated with a single dose varied. The clinical findings reportedly associated with acute radiation exposure were not significant in these 11 patients. (auth)

29030 LEUKEMIA FOLLOWING RADIOIODINE THERAPY OF HYPERTHYROIDISM. Sidney C. Werner (Columbia Univ., New York), Alan M. Gittelsohn, and A. Bertrand Brill. *J. Am. Med. Assoc.*, 177: 646-8 (Sept. 2, 1961).

Eighteen cases of leukemia in hyperthyroid patients previously treated with I^{131} were recorded through May 1960. Three cases were also recorded in which the onset of leukemia preceded I^{131} therapy. An excess of acute leukemia over that expected was observed. Data collected by S. C. Werner showed that there were 10 leukemia cases among 32,000 I^{131} -treated thyrotoxicosis patients followed for 142,000 person-years. Results indicate that there may be an increased risk of leukemia following I^{131} therapy. (M.C.G.)

29031 A NEW MODEL TO STUDY HEMATOPOIETIC TRANSPLANTATION ANTIGENS. Franco Celada and T. Makinodan (Oak Ridge National Lab., Tenn.). *J. Immunol.*, 88: 638-45 (June 1961).

A method for the study of hematopoietic transplantation antigens is described. It seems to fulfill the requirements for an immunochemical bioassay to be simple, sensitive, and quantitative. Recipient mice are primed with varying doses of homologous donor antigens, and donors with sheep RBC antigen. Ten days later the recipients are exposed to 800 r and injected intravenously with 24×10^6 spleen cells of the donor, followed by intraperitoneal injection of sheep RBC. Anti-sheep RBC titer is determined 6 days later and compared with the titer of non-primed controls. The RD_{50} (the dose of priming donor antigen capable of stimulating the host to reject 50% of the donor spleen cells) is 6×10^2 for viable bone marrow cells, 4×10^4 for bone marrow cells killed with x rays, 10^5 for liver cells, and 5×10^5 for testicular cells. No priming potency was found with even 10^7 RBC. (auth)

29032 INCIDENCE OF LEUKEMIA AND OTHER TUMORS IN THYMECTOMIZED IRRADIATED MICE BEARING THYMIC TRANSPLANTS. Roger W. O'Gara and Jewel Ards (National Cancer Inst., Bethesda, Md.). *J. Natl. Cancer Inst.*, 27: 299-309 (Aug. 1961).

The effect of transplants of thymic tissue from newborn mice on the incidence of radiation-induced leukemia was investigated in strain C57BL mice. Thymectomized irradiated mice were given either an intrasplenic or a subcutaneous transplant of neonatal thymic tissue or were subjected to a sham intrasplenic transplantation. In mice

bearing an intrasplenic transplant of thymic tissue and those given a sham intrasplenic transplant, there was essentially the same incidence of leukemia (10.5 and 8.7%, respectively). In mice bearing subcutaneous transplants of thymic tissue, there was a higher incidence of leukemia (31.6%) though not as high as the irradiated, nontymectomized control animals (63.6%). The thymic implants were identified in the spleens of 34% of the animals examined during the 14-month observation period after transplantation. Histologic study of early and late implants showed normal growth and development of the thymic tissue in the spleens of irradiated mice. An apparent increase in the incidence of epithelial tumors in thymectomized x-irradiated mice is discussed briefly. (auth)

29033 THE EFFECT OF RADIOIODINE ON THE THYROID GLAND, HYPOPHYSIS AND ADRENAL GLANDS IN RABBITS. G. I. Kutakh (Kubanskii Medical Inst., USSR). *Med. Radiol.*, 6: No. 6, 42-4 (June 1961). (In Russian)

Histological investigations were conducted on the effect of 30, 150, and 800 μC of I^{131} . Degenerative processes and hardening of the parenchyma of the thyroid gland were well pronounced upon introduction of 30 μC every two months. Upon introduction of 800 μC towards the third month the thyroid gland is almost completely replaced by connective tissue. The hypophysis shows an increase of the number of basophilic cells, while the adrenal gland shows induration of cells of the glomerular zone and absence of mitoses when 800 μC is administered. (auth)

29034 FUNCTION OF THE THYROID GLAND IN DOGS AT DIFFERENT PERIODS FOLLOWING TOTAL IRRADIATION. E. N. Antipenko, B. I. Davydov, and Yu. A. Klassovskii (Military-Medical "Order of Lenin" Academy, [USSR]). *Med. Radiol.*, 6: No. 6, 44-7 (June 1961). (In Russian)

Six months after total irradiation of dogs with 400-r of γ rays, an intensified activity of the thyroid gland not observed in the first months following the irradiation was found. It was attended in a number of cases by dystrophic and necrobiotic changes in the gland. The functional disturbances of the gland remained unchanged 9, 11, and 13 months after irradiation and, apparently, are associated with reduced synthesis of thyroid hormone. (auth)

29035 COMPARATIVE CHARACTERISTICS OF THE LEUKOCYTIC AND TEMPERATURE REACTION OF ANIMALS TO THE RADIATION EFFECT. N. A. Volokhova. *Med. Radiol.*, 6: No. 6, 53-8 (June 1961). (In Russian)

The nature of body temperature changes and peripheral blood composition, observed shortly after single total irradiation of rabbits (1500 r), shows that the temperature and leukocytic reactions become manifest simultaneously and irrespective of each other. During subsequent periods (24, 48, and 72 hours after irradiation) the leukocyte count changes with time following the irradiation and is not associated with the temperature reaction. This indicates that later on an augmented body temperature would not influence the quantitative composition of leukocytes. Temperature disorders following irradiation with 1500 r are marked to a lesser degree than changes of the white blood count. (auth)

29036 THE ROLE OF GENERAL EARLY REACTION OF MATERNAL ORGANISM IN THE MECHANISM OF INJURY OF THE FETUS BY IONIZING RADIATION. (N. A. Kalinina (Inst. of Obstetrics and Gynecology, Academy of Medical Sciences, USSR). *Med. Radiol.*, 6: No. 6, 58-62 (June 1961). (In Russian)

The effects of the radiosensitivity of the mother on the growth and development of fetuses were studied in rabbits. (C.H.)

29037 ELECTROCARDIOGRAPHIC CHANGES IN GUINEA PIGS DURING THEIR DEATH UNDER RAYS OF BETATRON 25 MEV. V. P. Polkovnikova (Tomsk Medical Inst., USSR). *Med. Radiol.*, 6: No. 6, 63-7 (June 1961). (In Russian)

Changes in the electrocardiogram were recorded for guinea pigs exposed to lethal doses of radiation from a 25 Mev betatron. (C.H.)

29038 THE INFLUENCE OF WHOLE-BODY ALPHA-IRRADIATION (EXPERIMENTAL RADIUM THERAPY) ON SOME HISTOCHEMICAL INDICES OF HORMONE ACTIVITY OF THE ADRENAL CORTEX. F. L. Leites (State Scientific-Research Inst. of Health Resort Studies and Physiotherapy, USSR). *Med. Radiol.*, 6: No. 6, 73-7 (June 1961). (In Russian)

Some histochemical indices of hormone activity of the adrenal cortex were investigated in connection with whole-body alpha-irradiation during experimental radium therapy. It was observed that radon baths (radon concentration of 33000 and 8000 Mache units) produce a distinct and statistically reliable stimulation of glyccorticoid secretion of the adrenal cortex, as compared with fresh water baths. (auth)

29039 THE BIOLOGICAL ACTION AND USE IN MEDICINE OF FAST ELECTRONS. N. V. Sokolova (Tomsk Medical Inst., USSR). *Med. Radiol.*, 6: No. 6, 83-7 (June 1961). (In Russian)

A review is given of the physical and biological properties of fast electron beams in radiotherapy. Reported results achieved with various doses and various fast electron sources are described. The majority of published data seem to lean to daily irradiation with 200 to 400 r with total doses of 4000 to 9500 r. However, H. Bode and associates recommend a single massive dose of 1500 to 2000 r for tissue, lip, or melanoma therapy. Tissue reactions are variable, however, in most cases a total dose of 3000 r induces erythema and 4000 r produces a moist epidermitis which can be liquidated in 3 to 4 weeks. In mucous membrane epithelitis develops as 2000 to 4000 r. One of the most important features of electron irradiation is the negligible injury to mucous or salivary gland, preventing serious complications caused by radioinduced dryness of the mucous tissue. Data are not available on the remote effects of electron therapy, however, the immediate effects are very satisfactory. Neither is there a final decision on which fast electron source, betatron or linear accelerator, is preferable for medical treatment. E. Uhlmann and his associates indicate advantages of the liner accelerator. (R.V.J.)

29040 EFFECT OF IRRADIATED NORMAL TISSUES ON THE GROWTH OF MOUSE CARCINOMA. Arthur Compton and Charles A. Pannett (St. Mary's Hospital, London). *Nature*, 191: 1101-2 (Sept. 9, 1961).

Grafts from the same fragment of tumor were implanted subcutaneously into 10 mice. Five of the mice were used as controls, and the other five were fed, either in liquid or solid form, irradiated normal tissues. In 23 experiments there was no evidence of inhibition in 6, and 17 showed disappearance of the growth or inhibition in some degree. It was concluded that for complete disappearance of a tumor a dose that will destroy at least 37% of it is required. (P.C.H.)

29041 DISTRIBUTION OF X-RAY- AND NITROUS ACID-INDUCED MUTATIONS IN THE GENETIC FINE STRUCTURE OF THE *ad*₁ LOCUS OF *SCHIZOSACCHAROMYCES POMBE*. Herbert Gutz (Technische Universität, Berlin). *Nature*, 191: 1125-6 (Sept. 9, 1961).

In the x-ray experiments, most of the mutants were

produced with 180-kev x rays at a dose of 30000 r. For the experiments with nitrous acid, cells starved for 6 hr in saline were incubated in acetate buffer at pH 4.0 and 0.03 M sodium nitrite at 30°C for 3 to 5.25 min. The treated cells were plated on yeast-extract agar. Thirty-two ad₇ mutants from x rays and 51 from nitrous acid were obtained. The results of intragenic recombination analyses show that the 32 x-ray mutants occupy one site only; they are considered as point mutations. No striking difference is observed in the distribution of mutants induced with UV light or x rays. Mutants obtained with nitrous acid are quite different. Twenty-nine out of the 51 were sensitive to temperature and showed pronounced hot spots different from the UV and x-ray mutants. (P.C.H.)

29042 X-RAY HAZARD DURING CEREBRAL ANGIOGRAPHY AND MYELOGRAPHY. Ryszard Chrznowski and Stanislaw Kwieciński. *Polski Przegląd Radiol. i Med. Nuklearnej*, 25: 393-403 (July-Aug. 1961). (In Polish)

The doses received by a patient and the working team executing cerebral angiography and myelography are presented. Ionization chambers were used to measure the doses. The dose received by the doctor while executing angiography without protective measures was: right hand 125 mr; left hand 112 mr; and male gonads 18 mr. The protective measures, lead rubber and keeping the radiologist's hands from the irradiated field, contributed to an appreciable reduction (88 to 93%) of the received dose. The myelographic examination delivers up to 50 mr to the lumbar region of the patient, and the right hand and legs of the radiologist are mostly endangered. (auth)

29043 CATALASE ACTIVITY, SENSITIVITY TO HYDROGEN PEROXIDE, AND RADIATION RESPONSE IN THE GENUS ESCHERICHIA. M. S. Engel and H. I. Adler (Oak Ridge National Lab., Tenn.). *Radiation Research*, 15: 269-75 (Sept. 1961).

In a group of three closely related *E. coli* strains there is no absolute correlation between catalase activity and radiation sensitivity. When these strains are made more resistant to ionizing radiation and H₂O₂ by physiological means, catalase activity is actually diminished. There is an excellent correlation between sensitivity to H₂O₂. Possible explanations for the inability of catalase to protect cells against H₂O₂ damage are discussed. Data obtained with a fourth *E. coli* strain that can be grown as a catalase-positive or -negative organism support these conclusions. (auth)

29044 EFFECT OF RADIATION ON THE EXCRETION OF SOME OF THE NITROGENOUS CONSTITUENTS OF URINE IN MAN. Erland C. Gjessing and Shields Warren (New England Deaconess Hospital, Boston). *Radiation Research*, 15: 276-89 (Sept. 1961).

A study was made of the effect of x irradiation on the urinary excretion of α -aminonitrogen and amino acids in patients with various forms of cancer. In two patients a more intensive study was made with respect to α -aminonitrogen, urea, creatine, creatinine, and cystine. The observed changes in excretion were not related to total x-radiation levels, number of treatments, or spacing of such treatments. The changes in excretion appeared rather to be related to the condition of the patient. In the patients showing an increase in α -aminonitrogen during x-radiation treatment, there was a concomitant rise in the level of amino acid excretion. In these patients, with few exceptions, the urinary amino acid pattern characteristic of the individual remained the same during treatment. (auth)

29045 DOSE DEPENDENCE OF RADIATION-INDUCED CREATINE EXCRETION IN RAT URINE. Georg B. Gerber,

Paul Gertler, Kurt I. Altman, and Louis H. Hempelmann (Univ. of Rochester, N. Y.). *Radiation Research*, 15: 307-13 (Sept. 1961).

Creatine excretion in urine of rats after whole-body exposure to various doses of x rays (25 to 1000 r) and after sham-irradiation was determined. Although creatinuria was observed at all levels of exposure, the degree was dependent on the dose. Creatinuria lasted from 3 to 16 days after exposure. In the intermediate dose range a second rise in the excretion of creatine was observed during the second week after exposure. The average creatine excretion during the initial 4 days after exposure varied linearly with the dose up to 650 r. (auth)

29046 URINARY EXCRETION OF SEVERAL METABOLITES IN PERSONS ACCIDENTALLY EXPOSED TO IONIZING RADIATION. Georg Gerber, Gisela Gerber, S. Kurohara, K. I. Altman, and L. H. Hempelmann (Univ. of Rochester, N. Y.). *Radiation Research*, 15: 314-18 (Sept. 1961).

Urinary concentrations of creatine, β -aminoisobutyric acid, pyrrole-carboxylic acid, and free hydroxyproline were determined in human subjects accidentally exposed to ionizing radiation at various time intervals after exposure. The range of doses of radiation varied from about 100 to 4000 rads. Increased concentrations of creatine and β -aminoisobutyric acid in urine were found in most of the patients. Excretion of free hydroxyproline was decreased in the three most heavily exposed patients, whereas pyrrole-carboxylic acid was increased only in the fatally injured patient. (auth)

29047 THE RESPONSE OF DOGS TO BILATERAL WHOLE-BODY Co⁶⁰ IRRADIATION. II. PATHOPHYSIOLOGICAL MANIFESTATIONS. James N. Shively, Sol M. Michaelson, and Joe W. Howland (Univ. of Rochester, N. Y.). *Radiation Research*, 15: 319-28 (Sept. 1961).

The mid-line tissue LD₅₀₍₃₀₎ dose for young adult dogs exposed to single bilateral whole-body doses of Co⁶⁰ γ radiation under the described conditions was 350 r. The radiation syndrome and pathological changes at autopsy were not different from those reported previously. The hematological, mucoprotein, and properdin responses were found to be similar to those for x or neutron irradiation. The incidence of bacteremia was lower than in x irradiated dogs. A correlation between leukocyte change between the seventh and tenth days after irradiation and decedence or survival is discussed. (auth)

29048 EFFECTS OF RADIATIONS OF DIFFERENT LET ON ARTEMIA EGGS. Stephen S. Easter, Jr. and Franklin Hutchinson (Yale Univ., New Haven). *Radiation Research*, 15: 333-40 (Sept. 1961).

Eggs of the brine shrimp *Artemia salina* were irradiated in the dry state and, after soaking in water, for various times with γ rays, 1-Mev electrons, and ions of helium, carbon, oxygen, and argon with an energy of 10 Mev/nucleon. Sigmoidal survival curves with a multiplicity of the order of 60 are found for irradiation with γ rays and electrons. The survival curves are changed to exponential ones for irradiation with the heavy ions, the transition for dry eggs occurring between helium and carbon ions. For the heaviest ions, the effective cross section per ion approaches a maximum value of the order of 0.15 μ^2 . Soaking the eggs in sea water for periods up to 25 hours decreases the survival with heavy ions only a little but drastically changes the sigmoidal survival curve for electrons, reducing the multiplicity from about 60 to about 4. These changes on soaking are about the same at 6 hours and at 24 hours. (auth)

29049 EFFECT OF AGING AND X-IRRADIATION ON THE KINETICS OF SKELETAL METABOLISM IN THE RAT. Stanton H. Cohn (Brookhaven National Lab., Upton, N. Y.). *Radiation Research*, 15: 355-65 (Sept. 1961). (BNL-5206)

The instantaneous rate of skeletal growth and metabolism in normal aging and after exposure to x-irradiation is compared. The radioisotope technique of Bauer was employed to quantify the alterations in the rate of accretion (A) and calcium exchange capacity (E) of various bones of young growing rats after whole- and partial-body x irradiation. In the animals in which one limb was exposed to 2000 r of x irradiation and compared with its contralateral control, the accretion rates of both the ends and the shaft of the tibia of the irradiated limb were depressed considerably, but the exchange capacity of the ends of the irradiated tibia showed a marked increase. In the tibiae exposed to 800 r, no effect on the accretion or exchange values was observed. It was found that, the A and E per unit ash weight differ markedly among the various bones and in different fractions of individual bones, and they were also differentially affected by radiation. Both these parameters in all bones, except the incisors, decreased as a function of age over the 140-day study period. After 500 r of whole-body x irradiation, the accretion rate decreased, whereas the exchange capacity of most bones showed a slight increase over that of the controls. These changes were most marked at 75 days after irradiation and showed a tendency toward recovery at 140 days. The whole-body x irradiation (500 r) must have an abscopal effect on skeletal growth, since 800 r delivered directly to the bone had no acute effect on either the A or the E value. Whether the effect of 500 r of whole-body irradiation is due to the resulting temporary inanition with its inhibition of body growth, or to a generalized effect on the body's calcium regulatory control mechanism, is not clear. Although the gross effects on skeletal tissue of aging and radiation are similar, closer observation of these processes (by measurement of metabolic parameters) indicates that they differ in certain respects. Thus, in terms of exchange capacity, there is no simple relationship between the effects of x irradiation and those of aging on skeletal metabolism. (auth)

29050 CHOLESTEROL AND LATHOSTEROL IN SEBUM OF X-IRRADIATED RATS. Harry Sobel and Yvonne Matesich (Saint Joseph Hospital, Burbank, Calif.). *Radiation Research*, 15: 366-71 (Sept. 1961).

A study was undertaken to determine whether exposure to x irradiation might be detected by analysis of the skin surface fat for products of sebaceous activity. Rats were exposed to 520 r in a single dose or 200 r weekly for 6 weeks and during the eighth week. In general, the level of cholesterol and lathosterol did not differ from that in non-irradiated animals. This suggests that study of sebum may not be a useful device for the detection of irradiation exposure. (auth)

29051 DEPENDENCE OF RATE OF RECOVERY FROM ACUTE GAMMA-RAY EXPOSURE ON SIZE OF THE CONDITIONING DOSE. J. F. Spalding, T. T. Trujillo, and W. L. LeSturgeon (Los Alamos Scientific Lab., N. Mex.). *Radiation Research*, 15: 378-89 (Sept. 1961).

A homogeneous population of 4658 RF female mice was used to study rate of recovery from acute Co^{60} γ exposure and its dependence on the magnitude of the first or conditioning dose. The time required for mice given a conditioning dose of 205 rads to repair 50% of the effect was 181 ± 18 hours, and the recovery rate was fit best by a linear expression. The RT_{50} for mice conditioned with 600

rads of γ rays was 161 ± 20 hours, and the recovery rate was fit best by an exponential expression. The 50% recovery times were not significantly different. Six groups of mice given γ exposures ranging from 205 to 692 rads showed an average residual damage of 48% of their initial exposure after 144 hours of repair. There were no significant variances in the per cent residual damage regardless of the size of the conditioning dose. It was concluded that the time required for RF female mice to repair one-half of the radiation damage from acute Co^{60} γ exposure was 7.0 days and that the RT_{50} was not influenced by the magnitude of the conditioning dose between the dose levels of 205 and 692 rads. (auth)

29052 RADIOSENSITIVITY AND CHROMOSOME NUMBERS IN STRAIN L MOUSE CELLS IN TISSUE CULTURE. J. E. Till (Ontario Cancer Inst., Toronto and Univ. of Toronto). *Radiation Research*, 15: 400-9 (Sept. 1961).

The radiosensitivity of the ability of strain L mouse cells to form macroscopic colonies was found to be independent of chromosome number in cell lines with mean chromosome numbers between 53 and 109 chromosomes. The radiosensitivity of L-cells appears to be relatively low in comparison with values reported for other mammalian cell lines. (auth)

29053 THE DOSE-RESPONSE RELATIONSHIPS OF BETA-RAY-INDUCED SKIN TUMORS IN THE RAT. Roy E. Albert, William Newman, and Bernard Altshuler (New York Univ. Medical Center, New York and George Washington Univ. School of Medicine, Washington, D. C.). *Radiation Research*, 15: 410-30 (Sept. 1961).

Single doses of β radiation ranging from 230 to 10000 rads were applied to 35-cm² skin areas on the backs of young male rats. The resultant dose-tumor incidence curves were highly nonlinear: the incidence of tumors of all types increased abruptly at about 2000 rads, reached a peak at about 4000 rads, and declined at higher doses. The sharp upturn in tumor formation occurred at doses which produced mild to moderate skin damage, while markedly pilocidal doses had a suppressing effect on the formation of adnexal tumors. There was a shifting distribution of tumor types with respect to dose: the hair follicle and sebaceous tumors predominated at the intermediate levels, whereas epidermoid carcinomas were more common at doses which produced very severe skin damage. The appearance time of tumors seemed to have little dose dependence in contrast to the magnitude of tumor incidence. The frequency distribution of tumors on individual rats was found to conform fairly well to a calculated Poisson distribution, suggesting that the presence of some tumors on the irradiated skin does not markedly affect the formation of others. (auth)

29054 MODIFICATION OF RADIATION RESPONSES OF TISSUE BY COLCHICINE. Melvin L. Griem, Frederick D. Malkinson, and Peter H. Morse (Argonne Cancer Research Hospital, Chicago). *Radiology*, 77: 486-92 (Sept. 1961).

The technic for microscopic examination of rodent hairs was used to determine whether colchicine exerts a synergistic effect on dysplastic changes in growing hairs induced by local x irradiation. The experimental findings indicate that significant synergism occurs, but only when a specific time interval of sixteen hours separates colchicine administration from x irradiation. No other time interval studied consistently exerted a similar effect. No protective action of colchicine was noted. Increased responsiveness to x irradiation following intravenous administration of colchicine was observed in a single patient with mycosis fungoides. (auth)

29055 THE EFFECT OF X-RAYS ON MALE GERM CELLS OF *MACACA MULATTA*. 1. THE SENSITIVITY OF SPERMATOGONIA. H. Wang (Inst. of Biophysics, Academia Sinica, Peking), H. L. Wu, S. L. Chen, T. S. Chang, and T. S. Tsien. Sci. Record (Peking) (N. S.), 4: 33-40 (Jan. 1960). (In English)

Nine male monkeys of ages from 6 to 14 years received different doses of x-radiation. The testes were prepared for series sections by the ordinary method, and observations were made on the radiosensitivity of the different stages of cells during spermatogenesis. As observed in the sections of testes of different ages, the first noticeable change is the reduction of the number of spermatogonia and the pycnosis of their nuclei. The radiosensitivity of spermatogonia is directly proportional to the dose given. As the dose gradually increases the number of spermatogonia gradually decreases, while the number of abnormal cells will increase. After the 200 r irradiation, the recovery of the spermatogonia is not noticed, even after fifty days of irradiation. The radiosensitivity of the male germ cells of the monkey, *Macaca mulatta*, is higher than that of mice, rats, and guinea pigs. (auth)

29056 EFFECTS OF A SINGLE SESSION OF X-IRRADIATION ON PERIPHERAL BLOOD OF RHESUS MONKEY (*MACACA MULATTA*). Siu-choun Ma (Inst. of Biophysics, Academia Sinica, Peking) and Ann-chi Wong. Sci. Record (Peking) (N. S.), 4: 41-53 (Jan. 1960). (In English)

Rhesus monkeys (*Macaca mulatta*), 11 male and 3 female, aged 6 to 19 years, were used for study on the effects of a single session of x-irradiation (doses 200 r-600 r) on the blood picture. Separated whole-body irradiation (the upper and lower halves of the body irradiated separately) caused more severe injury than whole-body irradiation at one time. The primary cause of death for animals 1-2 weeks after irradiation was found to be bone marrow aplasia. Counts of erythrocytes, leukocytes made, and the concentration of hemoglobin estimated 2-3 days before death were lower, and the non-filament neutrophils and degenerated leucocytes (which did not show significant change in number after irradiation in survivors) were higher than those of the survivors receiving the same doses of irradiation. These changes may be regarded as prognostic signs for radiation death. Leucocytes, neutrophils, and monocytes rose markedly 6 hours after irradiation and were higher in the lower dose group than in the higher one. This difference may be due to the peak of elevation in the higher dose group taking place prior to 6 hours. The degree of reduction, time of beginning, and completion of recovery of leucocytes, eosinophils, lymphocytes, and monocytes after irradiation bore certain relationships to the size of the doses. The reduction was greater and time for start and completion of recovery longer in the higher dose group than those in the lower one. Neutrophils with toxic granules, binucleated lymphocytes, and degenerated lymphocytes were also found more frequently in the higher dose group than in the lower one. Neutrophils increased markedly immediately after irradiation to 2-6 times of their preirradiation level, and most of them showed signs of pre-necrosis. At the same time non-filament neutrophils rose from their preirradiation level of 2-4% to 5-40% and caused a left shift of the blood picture. Thereafter, neutrophils fell rapidly, and during the first 3 days of reduction, cells with nuclei of 6-10 lobes increased markedly to 2-6 times of their preirradiation level, many of them being giant in size. Hence, a shift to the right of the blood picture was observed a few days after irradiation. Eosinophils, which almost entirely disappeared immediately after ir-

radiation, returned to normal in 2 days and disappeared again in a few weeks followed by eosinophilia. The small lymphocytes were more radiosensitive than the medium and large ones. The lymphocytes which disappeared after irradiation and reappeared during recovery mostly belonged to the small type. Degenerated lymphocytes increasing to about 0.5-5%, 1-4 days after irradiation, were almost 2-20 times above the normal level. (auth)

29057 EFFECTS OF A SINGLE SESSION OF HALF BODY X-IRRADIATION ON THE PERIPHERAL BLOOD OF RHESUS MONKEY (*MACACA MULATTA*). Siu-choun Ma (Inst. of Biophysics, Academia Sinica, Peking). Sci. Record (Peking) (N. S.), 4: 111-19 (Feb. 1960). (In English)

Rhesus monkeys (*Macaca mulatta*), 8 male and 5 female, aged 2 to 6 years, were used for study on the effects of a single session of half-body x-irradiation (doses: 50 r-200 r) on the blood picture. The pattern of response of blood elements of the monkeys following lower dose (50 r-200 r) half-body x-irradiation agrees broadly with that of the higher dose (200 r-600 r) whole-body one. The total leucocyte counts estimated 3 days after irradiation depressed considerably. This depression was mainly due to the reduction of lymphocytes. Neutrophils did not decrease significantly in the first three days after irradiation but afterwards they were also reduced. Neutrophils with toxic granules, multi-lobed nuclei, and giant size, and neutrophil metamyelocytes and cells with toxic basophilic granules appeared after irradiation. In eosinophils, the degree of reduction was greater and the time for recovery longer in the higher dose group than in the lower one. Eosinophilia occurred in the higher dose group (200 r) but was not present in the lower ones 1.5 months after irradiation. There were certain specific features in the blood picture of animals with their right half-body irradiated (the spleen being out of irradiation): instead of depression of lymphocytes count 3 days after irradiation, neutrophils decreased markedly; and unlike the left half-body irradiated animals, their monocyte counts did not show marked depression and returned to the normal level very soon. In lymphocytes, the degree of reduction was greater and the time required for recovery longer in the higher dose group than in the lower one. The small lymphocytes were more radiosensitive than the medium and large ones. The quantitative change of lymphocytes after irradiation was mainly due to increase or decrease of small lymphocytes. Binucleated lymphocytes, lymphocytes with unequally divided nuclei, and transitional forms between lymphocytes and monocytes, or lymphoblasts and degenerated lymphocytes appeared. The latter were more easily observed immediately after irradiation. There were no conspicuous changes in the number of erythrocytes, platelets, and concentration of hemoglobin after irradiation. Giant platelets also appeared some time after irradiation. No significant change in the number of degenerated leucocytes was found after irradiation. (auth)

29058 THE EFFECT OF IONIZING RADIATION ON SOME PHYSICO-CHEMICAL PROPERTIES OF BOVINE PLASMA ALBUMIN. Lin-fang Wang and Chih-chuan Liang (Inst. of Experimental Medicine, Chinese Academy of Medical Sciences). Sci. Record (Peking) (N. S.), 4: 395-403 (June 1960). (In English)

A marked increase in the combining power of bovine plasma albumin for S^{35} -methionine was observed even with small doses of irradiation, and the combining power continued to increase as the dosage of irradiation increased. The rate of increase of the combining power began to decline after irradiation was increased to 2500 mc-

hr. The intrinsic viscosity of bovine plasma albumin changed very little after different amounts of irradiation within the present dosage limit. The specific rotation of bovine plasma albumin did not change considerably under rather wide pH limits. After irradiation, the change of specific rotation was still very little between pH 5-7. Marked changes in specific rotation were observed when the pH of the irradiated albumin solution was lowered under 5 or raised above 7, and the more irradiation the sample received, the more pronounced these changes were. The molecular weight of bovine plasma albumin decreased after irradiation, but after irradiation reached 5000 mc-hr, the molecular weight showed very little change on further increasing the amount of irradiation up to around 10000 mc-hr. (auth)

29059 THE EFFECT OF IONIZING RADIATION ON THE ANTIGENICITY OF BOVINE PLASMA ALBUMIN. Lin-fang Wang and Chih-chuan Liang (Inst. of Experimental Medicine, Chinese Academy of Medical Sciences). Sci. Record (Peking) (N. S.), 4: 404-6 (June 1961). (In English)

The antigenicity of pure bovine plasma albumin decreases after irradiation with radon over 5000 mc-hr. Under the conditions used, the change depends mainly on the dosage and not on the intensity of irradiation. (auth)

29060 EFFECT OF IONIZING RADIATION ON SOIL MICROORGANISMS. Richard Stanovick, Joel Giddens, and R. A. McCreery (Univ. of Georgia, Athens). Soil Sci., 92: 183-7 (Sept. 1961).

The effects of neutron and gamma radiation on soil bacteria, actinomycetes, and fungi, and on nitrifying bacteria, nitrogen fixation, and CO_2 evolution were studied. Soil samples from alfalfa and ammonia-treated soils at two moisture levels were exposed at a dosage of 4.13×10^{12} neutrons per cm^2 and a mean gamma dosage of 3.4×10^{12} ergs per g. Similar studies were made on soil samples taken at varying distances from the reactor after a run of 735 megawatt hours of operation, which gave a cumulative mixed neutron and gamma dosage ranging from over 100000 rems at 100 feet to 9000 rems at 700 feet. The results of the investigation may be summarized as follows: The bacteria and actinomycetes were reduced by about two-thirds in the irradiated soil samples taken from the alfalfa and ammonium-fertilized plots; the total fungi increased two-fold in the irradiated soil from the alfalfa plot, but a consistent effect was not obtained on fungi in the irradiated soil obtained from the plot fertilized with ammonium carriers; soil moisture content did not influence the radiation effects; irradiation reduced the rate of nitrification by two-thirds after 2 weeks of incubation and by one-half after 4 weeks of incubation; irradiation increased the amount of nitrogen mineralized in the soils studied; the irradiated alfalfa soil was sterile with respect to *R. meliloti*; carbon dioxide evolution from the irradiated alfalfa soil did not differ from the nonirradiated; soil microflora in the vicinity of the reactor was more related to the environmental conditions of that immediate area than to the total radiation dosage; nitrification in soil near the reactor was not related to the total radiation dosage; and *Lespedeza Rhizobia* present in soil increased as the distance from the reactor increased. From these results, it is concluded that the nitrogen-fixing bacteria are more susceptible to radiation than the other groups of soil microorganisms studied, and the lethal levels of radiation required for the groups of soil microorganisms studied are relatively high when protected by several inches of soil. (auth)

29061 GENETICS IN THE ATOMIC AGE. Eugen Sănduleac. Știință și Tehnică, No. 9, 18-19 (1960).

The transformation of the nature of plants, microorganisms, animals, and human beings by radiation is reviewed. Various works from the Soviet Union and their results are discussed. (P.C.H.)

29062 INFLUENCE OF γ -IRRADIATION ON STIMULATING PROPERTIES OF TISSUE EXTRACTS. G. D. Tumanishvili. Trudy Inst. Fiz. Akad. Nauk Gruzin. S.S.R. 7: 113-17 (1960). (In Russian)

Results from experiments on irradiated tissue extracts are given. The dose was about 1000 rep. The stimulating effect of tissue extracts of chick embryos was not destroyed by gamma irradiation. The activity of the extract was increased when frog liver regeneration was studied. The results exclude almost completely the participation of DNA or DNP in the stimulation of growth and differentiation of homologous tissues (organs). (auth)

29063 EFFECT OF IONIZING RADIATION ON PHOSPHOPROTEIN METABOLISM. R. P. Vinogradova (Shevchenko State Univ., Kiev). Ukrain. Biokhim. Zhur., 33: 498-502 (1961). (In Ukrainian)

A study was made of the quantity and intensity of phosphoprotein phosphorus renewal, as well as of the phosphoprotein phosphatase, in the bone marrow, spleen, and liver on the 1st, 3rd, 5th, 7th, and 10th days after irradiation. Irradiation of animals was found to cause a decrease in the phosphoprotein phosphorus in all investigated tissues at all periods of radiation sickness. The specific activity of the phosphoprotein phosphorus is considerably raised after irradiation. A considerable increase was noted in the relative specific activity of phosphoprotein phosphorus in the liver, spleen, and bone marrow at various periods of radiation sickness. The phosphoprotein phosphatase activity in the bone marrow and liver is lowered, particularly on the 10th day after irradiation. In the spleen the activity of this enzyme is lowered on the 1st day and is raised on the 5th and 7th days of radiation sickness. (auth)

29064 RADIOBIOLOGIC AND DOSIMETRIC PROBLEMS IN RADIOTHERAPY OF BRAIN TUMORS. AN EXPERIMENTAL AND CLINICAL STUDY. Martin Lindgren. Thesis, Lund; Sweden, University of Lund, 1958. 12p. (In English)

Studies were made on dosimetry in roentgen irradiation of brain tumors, radiobiologic studies on tolerance of brain tissue in rabbits and man, and radiosensitivity of brain tumors. Several conclusions are given: After correction for bone absorption in the absorption of radiation in human brain tissue, standard tables could be used for dose calculation in the treatment of brain tumors. In the study of dose distribution in treated areas, it was found that appreciable improvement can be attained only by radical modification of the technique. The assumption that time-dose relationship curves for brain and skin in any given mammal will correspond seems justified. Discussion is also given on the reliability of depth dose tables, time-dose relationship curves for brain and skin reactions in rabbits, and the comparison between slope and dose range in rabbits and man. (P.C.H.)

29065 PLANTS AND X RAYS. L. B. Breslavets. Translated from Russian by Alena Elbl. Washington, D. C. The American Institute of Biological Sciences, 1960. 127p.

The material presented is primarily a summary of the older literature in plant radiobiology and covers much Russian work not reviewed previously in English. Some unpublished data are also included. A brief introduction is

given on the discovery of x rays, study of their biological and medicinal properties, naming, units of measurement, and physics of the rays. Discussion is given on physiological changes due to the action of x rays, changes in morphological characteristics, intracellular changes, and the effect of the quantity and quality of the rays on the transformation of plants. Much of the authors own work is given on winter rye, peas, hemp, meadow grasses, and wheat. 474 references are given, and separate author and subject indexes are included. (P.C.H.)

29066 PROCEEDINGS OF THE FOURTH ANNUAL TRI-SERVICE CONFERENCE ON THE BIOLOGICAL EFFECTS OF MICROWAVE RADIATION, 16-18 AUGUST 1960, NEW YORK UNIVERSITY MEDICAL CENTER. VOLUME I. Mary Fouse Peyton, ed., New York, Plenum Press, 1961. 341p. \$10.00.

Proceedings of the Fourth Annual Tri-Service Conference on the Biological Effects of Microwave Radiation are presented. Topics covered include the radiofrequency environment, basic problems in measuring RF field strength, microwave instrumentation for the measurement of biological effects, generation and detection of pulsed x rays from microwave sources, quick formulas for radar safe distances, some engineering aspects of microwave radiation hazards, development of a garment for protection of personnel working in high-power RF environments, the time constants of pearl-chain formation, the effect of microwave radiation on the male endocrine system of the rat, effects of radiofrequency energy on human gamma globulin, longevity and cellular studies with microwaves, phantom experiments with microwaves at the University of Rochester, relative microwave absorption cross sections of biological significance, biological effects of microwave energy at 200 mc, effects of 2450 mc microwaves in dogs and larvae of the common fruit fly, the effect of 2450 mc radiation on the development of chick embryo, specific thermal effects of high-frequency fields, microwave radiation in relation to biological systems and neutral activity, neurological effect of 3-cm microwave irradiation, biomedical aspects of microwave irradiation of animals, changes in the ascorbic acid content in lenses of rabbit eyes exposed to microwave radiation, preliminary results of studies of the lenticular effects of microwaves among exposed personnel, a review of unanswered biological hazard operational problems, technical aspects of the Navy HERO program. (M.C.G.)

29067 RADIATION-INDUCED AGING IN MICE. Howard J. Curtis (Brookhaven National Lab., Upton, N. Y.). p.114-28 of "Radiobiology." London, Butterworths, 1961. (BNL-4842)

Acceleration of the aging process in mice by radiation is being investigated. Studies of dose-effect relationships for gamma and x rays indicated that no threshold exists, and no matter how low the dose rate, there will always be some effect on the life span. It was found that for small doses, an animal must accumulate about 4 times as much gamma or x radiation applied chronically as is necessary to produce the same effect with a single dose. For neutrons it was found that the same total dose of radiation will produce a given degree of life-shortening regardless of whether it is given in a chronic or acute dose. The accumulated stress theory of aging and the somatic mutation theory are discussed. It was estimated that the radiation dose necessary to double the mutation rate in mammals is of the order of 50 r, whereas the dose necessary to cause a shortening of the life span by 50% is at least 10 times this value. (M.C.G.)

Radiation Sickness

29068 EVALUATION OF THE PLACEBO EFFECT IN THE TREATMENT OF RADIATION SICKNESS. John A. Parsons, John H. Webster, and J. E. Dowd (Roswell Park Memorial Inst., Buffalo). *Acta Radiol.*, 56: 129-40 (Aug. 1961). (In English)

A method for determining the proportion of placebo reactors in a double blind study of patients receiving medication for radiation sickness is described. The proportion of placebo reactors lies between 61 and 72%. The factors which most closely affect this proportion are the site of irradiation, sex of patient, and (total) cumulative integral dose of radiation. No evaluation of the effectiveness of prochlorperazine as an anti-emetic was attempted because of the small number of cases involved. (auth)

29069 RADIOPROTECTIVE EFFECT OF AMINOALKYL THIOESTERS. Bertil Hansen and Bo Sörbo (Research Inst. of National Defence, Sundbyberg, Sweden). *Acta Radiol.*, 56: 141-4 (Aug. 1961). (In English)

Certain aminoalkyl thioesters were investigated as radioprotective agents. Aminoethyl thiophosphoric acid (as the sodium salt), with a protective effect comparable to that of cysteamine, was the most effective of the compounds studied. (auth)

29070 EFFECT OF DIBENAMINE ON LD₁₀₀ FOLLOWING SUPRALETHAL DOSE OF TOTAL BODY GAMMA RADIATION. Stanley W. Handford and Paul W. Johnson (Naval Medical Research Inst., National Naval Medical Center, Bethesda, Md.). *Am. J. Physiol.*, 201: 347-8 (Aug. 1961).

Dibenamine, an adrenergic blocking agent, was administered to dogs immediately before they were subjected to a supralethal dose of whole body radiation. No significant differences in the course of acute radiation sickness or survival time (LD₁₀₀) between the treated and sham-treated control groups were observed. (auth)

29071 EFFECT OF HEMORRHAGE ON LD₁₀₀ OF DOG FOLLOWING SUPRALETHAL DOSE OF TOTAL BODY GAMMA RADIATION. Stanley W. Handford and Paul W. Johnson (Naval Medical Research Inst., National Naval Medical Center, Bethesda, Md.). *Am. J. Physiol.*, 201: 349-50 (Aug. 1961).

To test the effect of hemorrhage on survival following whole-body exposure to a supralethal dose of radiation, three groups of dogs were bled 25% of their estimated blood volume. In group 1, bleeding was accomplished immediately before irradiation; in groups 2 and 3, 30 min and 48 hr, respectively, following irradiation. No significant alterations in the course of acute radiation sickness or survival time (LD₁₀₀) were observed. (auth)

29072 GRANULOCYTE RELEASE BY ENDOTOXIN IN NORMAL AND IRRADIATED MICE. Willie W. Smith, Ilo M. Alderman, and Jerome Cornfield (National Institutes of Health, Bethesda, Md.). *Am. J. Physiol.*, 201: 396-402 (Aug. 1961).

Granulocyte mobilization brought about by *S. typhosa* endotoxin was studied in normal and irradiated mice in which initial counts ranged from 100 to 5000/mm³ in tail blood and 100 to 1800/mm³ in orbital sinus blood. In irradiated mice, 4-11 days after exposure, late occurrence of granulocytosis and absence of a peak at beginning of mobilization are presumably related to marrow aplasia. A transitory increase in percentage of young forms and a thinning of cellular population density in femoral marrow

indicates an early contribution from this source. Although counts from tail blood during peak mobilization were extremely high compared to counts from orbital sinus blood, a few hours later mobilization ratios in both tail and sinus blood were the same for irradiated and nonirradiated mice, without regard to initial count. (Mobilization ratios were about twice as high in tail blood as in sinus blood.) A multi-compartment system is proposed which is compatible with constant mobilization ratios. Under this model, when rate of delivery from marrow is slow relative to rates of transfer between compartments, ratios of compartment sizes become a constant independent of time and initial conditions and dependent only on magnitude of rate constants. (auth)

29073 THE USE OF TRIMETHOBENZAMIDE (TIGAN) FOR THE TREATMENT OF RADIATION INDUCED NAUSEA AND EMESIS. J. A. Burwell, B. Wolfson, C. R. Perryman, and F. F. Foldes (Mercy Hospital, Pittsburgh). *Am. J. Roentgenol., Radium Therapy Nuclear Med.*, 86: 752-6 (Oct. 1961).

Of 276 consecutive patients treated with cobalt 60 tele-radiation with skin doses ranging from 1250 to 2000 r per week, 54 complained spontaneously of emesis and/or nausea. The incidence of vomiting and/or nausea was 38, 22, and 5% following irradiation of the abdomen, thorax, and other parts of the body, respectively. Of the 54 patients who developed vomiting and/or nausea, 31 received 200 mg tigan by mouth four times daily, and 23 were given a placebo of identical appearance. The study was carried out with a double blind technique. Tigan produced some degree of relief in 80.6% of the patients and was ineffective in 19.4%. The corresponding figures for placebo medication were 60.8 and 39.2%. In patients with severe symptoms, neither tigan nor the placebo was completely effective. Whereas tigan gave partial relief in 50% of these cases, no relief at all was obtained with the placebo. In patients with moderate symptoms, tigan gave complete relief in 57% and partial relief in 29%. The placebo gave complete relief in only 8% and partial relief in 59%. In patients with mild symptoms, tigan and the placebo were almost equally effective. No side effects were encountered with tigan. It is concluded that tigan is an effective antiemetic in radio-induced nausea and vomiting. (auth)

29074 STUDIES OF THE IRRADIATION PROTECTION EFFECT OF FETAL LIVER IN MICE. I. INFLUENCE OF THE GESTATIONAL AGE OF THE DONOR TISSUE. Paul N. Tschetter, John H. Githens, and M. Giovannella Moscovici (Univ. of Colorado Medical Center, Denver). *Blood*, 18: 182-6 (Aug. 1961).

The gestational age of donor hematopoietic tissue appeared to have no influence on 30-day mortality following homologous transplants in irradiated mice. Recipients of second trimester homologous donor tissue had a late (90 day) mortality that was 16% lower than that observed in animals receiving tissue from third trimester and neonatal donors, but statistical analysis showed a low level of significance. Irradiation alone appeared to cause a late mortality in non-injected irradiated animals and in isologously transplanted irradiated animals. (auth)

29075 THE INFLUENCE OF SUCCINYL-SULFATHIAZOLE (SULFASUXIDINE) UPON THE RESPONSE OF CANINE SMALL INTESTINE TO IRRADIATION. John S. Spratt, Jr., Peter Heinbecker, and Sidney L. Saltzstein (Washington Univ. School of Medicine, St. Louis). *Cancer*, 14: 862-74 (July-Aug. 1961).

A study was carried out to determine whether the injury attending intense segmental intestinal irradiation could be reduced by diminishing and altering the intestinal bacterial

flora. Sulfasuxidine administration for 3 days before and 6 weeks after irradiation of isolated segments of canine ileum with 4000 r significantly reduced the lethality attending the irradiation of 15-cm lengths of ileum and reduced the inflammatory cell infiltration and edema and increased the vascularity of the granulation tissue internally lining the mucosally denuded areas of 5-cm lengths of ileum. Following the rapid complete loss of mucosa attending irradiational injuries of 4000 r, the size of the mucosally denuded area was reduced by exponential longitudinal shortening by the absorption of the irradiated muscle and connective tissue. An almost complete spontaneous anastomosis of proximal and distal nonirradiated intestine was effected 8 months after the irradiation of 5-cm lengths of ileum. The administration of Sulfasuxidine did not influence this rate of absorption. The mechanisms of the obstruction of the irradiated intestines are discussed. (M.C.G.)

29076 ADENOSINE TRIPHOSPHATASE ACTIVITY OF THE BRAIN OF RATS SUBMITTED TO X-IRRADIATION. A. Rabassini, C. S. Rossi, and G. Gregolin (Università, Padua). *Ital. J. Biochem.*, 10: 84-7 (Mar.-Apr. 1961). (In English)

Adenosine triphosphatase (ATPase) activity was studied in the brain of rats receiving whole-body x irradiation in doses of 600, 800, and 1000 r. Irradiation led to a decrease in ATPase activity which was proportional to the dose applied. The results are discussed in the light of previous studies in which, under the same experimental conditions, a decrease in brain ATP was observed. This decrease cannot be accounted for by increased activity of ATPase but by a diminution in synthetic processes. (auth)

29077 ELECTROCARDIOGRAPHIC CHANGES IN RABBITS IN THE ACTION OF INCORPORATED POLONIUM AND ROENTGEN RAYS. S. P. Grozdov. *Med. Radiol.*, 6: No. 6, 48-53 (June 1961). (In Russian)

Electrocardiographic investigations were carried out on changes of cardiac activity in rabbits with acute radiation sickness caused by x irradiation and subcutaneous administration of Po. Early changes of cardiac activity in rabbits subjected to x irradiation are due to a great extent to dystrophic phenomena in the myocardium occurring as the result of elevated content of adrenaline in the blood during the first hours after irradiation. At the peak of the disease electrocardiographic peculiarities indicate hypocalcemia. The electrocardiographic changes in rabbits after the introduction of Po are provoked apparently by an increase in the K content and decrease of Ca in the blood plasma. (auth)

29078 THE PROTECTIVE EFFECT OF HYPOXIA IN SHORT-TERM AND LONG-TERM IRRADIATION OF MICE WITH GAMMA-RAYS. I. B. Bychkovskya (Central Scientific-Research Inst. for Medical Radiology, Ministry of Health, USSR). *Med. Radiol.*, 6: No. 6, 68-72 (June 1961). (In Russian)

The survival of white mice is compared when exposed for 1 to 2 hr and 10 hr to gamma irradiation (Co^{60}) in conditions of oxygen deficiency (depression of 260 mm Hg). A preliminary analysis is given of the causes of the disappearance of the protective effect of hypoxia in prolonged irradiation. (auth)

29079 CONTENTS OF COPPER, MANGANESE AND ZINC IN GUINEA PIG ORGANS IN ACUTE RADIATION SICKNESS. G. A. Babenko (Stanislav Medical Inst., Ukrainian SSR). *Ukrain. Biokhim. Zhur.*, 33: 584-93 (1961). (In Ukrainian)

The dynamics of the contents of copper, manganese, and

zinc in the brain, liver, kidneys, spleen, sex glands, muscles, and bones of guinea pigs irradiated with lethal doses of x rays were studied. The microelement content in the tissues and organs changed within four hours after irradiation. In the muscle tissue and sex glands the alterations in copper, manganese, and zinc metabolism occur in the same direction and are distinguished by a decrease in the content

of these microelements, while in the blood and bones irradiation induced an increase in the copper and zinc content. Changes in the content of copper, manganese, and zinc in the liver, brain, kidneys, spleen, and lungs in the acute form of radiation sickness are distinguished by individual features for each microelement, differing in the time of the appearance, direction, and degree of the change. (auth)

CHEMISTRY

General and Miscellaneous

29080 (AERE-R-3767) THE CHARACTERISATION OF PRECIPITATES BY FILTRATION AND SETTLING PARAMETERS: A COMPARISON OF AMMONIUM DIURANATE AND URANIUM(IV) OXALATE. R. G. Sowden and G. N. Stockdale (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). June 24, 1961. 33p.

Methods are presented by which the filtration and settling properties of a precipitate may be characterized. The filtration resistance of a bed can be described by the Carman resistance, r_1 , and the hindered settling rate of a flocculated precipitate by a constant p/s , derived from the Kozeny relationship. The concepts were applied to a comparison of the properties of two uranium precipitates, ammonium diuranate (ADU) and uranium(IV) oxalate. Although r_1 and p/s varied widely in both cases with the conditions of precipitation, the oxalate precipitate had generally far better handling characteristics than ADU, particularly when continuous precipitation was employed. It seemed probable that a process involving simultaneous reduction of U(VI) and precipitation of U(IV) oxalate could be developed. Microscopic examination of the precipitates indicated that the variability in the properties of ADU cannot be understood solely in terms of crystallite size. Analysis of the filtration data in terms of flow through a settled bed revealed that the bed porosity is considerably lower than that indicated by the bed density, particularly in the case of some of the ADU precipitates. (auth)

29081 (AFOSR-1333) THE INTERACTION OF PARAMAGNETIC IONS AND ALUMINUM NUCLEI IN RUBY. Carl M. Verber (Colorado. Univ., Boulder). July 1961. Contract AF49(638)-611. 81p.

The techniques of continuous and pulsed nuclear magnetic resonance were used to study the Al nuclei in ruby crystals. Four commercially prepared samples having nominal Cr ion concentrations of 0.01, 0.1, 1.5, and 4% were investigated at 300, 78, 4, and 1.7°K. The line widths were found to be due to the mutual interaction of the Al nuclei, and the paramagnetic ions. The relaxation times were found to be a strong function of the Cr ion concentration. An effort was made to predict these times, using known values of the Cr relaxation times and existing theories in which the nuclear relaxation times are given in terms of the paramagnetic relaxation times. No agreement was found between theoretical and experimental values, and a revision of existing theories is indicated. (auth)

29082 (BM-RI-5847) THERMAL EXPANSION AND PHASE INVERSION OF RARE-EARTH OXIDES. Stephan Stecura and William J. Campbell (Bureau of Mines. College Park Metallurgy Research Center, Md.). Oct. 1960. 51p.

Thermal expansion and phase inversion measurements are reported on oxides of Sc, Y, La, and 12 lanthanide series elements up to 1350°C. (J.R.D.)

29083 (CNI-91) EQUILIBRIA BETWEEN TRI-n-OCTYLAMINE AND SOME MINERAL ACIDS. U. Bertocci and G. Rolandi (Italy. Comitato Nazionale per le Ricerche Nucleari. Centro di Studi Nucleari, Ispra). Jan. 1961. 24p.

Equilibrations between tri-n-octylamine dissolved in

xylene, and an aqueous phase consisting of solutions of, respectively, nitric, hydrochloric, hydrofluoric and sulfuric acid were carried out; the acid and water content in the organic phase was determined. The experiments were performed at several amine and acidic concentrations. The results showed that the acidic concentration in the organic phase at equilibrium is generally higher than the amount necessary to convert all the amine into the corresponding salt. Third phase formation was found only in the case of certain equilibrations with sulfuric acid. The solubility of water in the organic phase was found to be rather small. (auth)

29084 (DP-602) PREPARATION OF URANIUM(IV) NITRATE SOLUTIONS. Robert S. Ondrejcin (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). July 1961. Contract AT(07-2)-1. 10p.

A procedure was developed for the preparation of uranium(IV) nitrate solutions in dilute nitric acid. Zinc metal was used as a reducing agent for uranium(VI) in dilute sulfuric acid. The uranium(IV) was precipitated as the hydrated oxide and dissolved in nitric acid. Uranium(IV) nitrate solutions were prepared at a maximum concentration of 100 g/l. The uranium(VI) content was less than 2% of the uranium(IV). (auth)

29085 (HW-68910) SLIP CASTING OF MAGNESIA-TITANIA BODIES. R. S. Rosenfels (General Electric Co. Handord Atomic Products Operation, Richland, Wash.). Mar. 10, 1961. Contract W-31-109-Eng-52. 24p.

Presented at the American Ceramic Society, Toronto, Canada, April 25, 1961.

Titania is known to increase the rate of diffusion and sintering in pressed magnesia-titania bodies. To meet a need for dense ceramic containers which would hold a molten chloride eutectic, methods were developed for slip casting and sintering fused magnesia containing 10 wt% titania. The procedures were based on the Los Alamos method of slip casting fused and milled magnesia using water as the vehicle. The principal variables studied were pretreatment of the titania (calcined or non-calcined); nature of the deflocculant; percentage of coarse magnesia added to the milled magnesia-titania slurry; sintering temperature. Magnesia-titania cells and auxiliary pieces were produced which retained the molten chloride at 800°C for several hours. Several of the formulations resulted in a glazed body. (auth)

29086 (ISC-1177) STRUCTURE, MOLECULAR ORIENTATION AND MECHANICALLY INDUCED REORIENTATION OF MOLECULES IN MULTIMOLECULAR FILMS OF LONG-CHAIN N-HYDROCARBON DERIVATIVES. Chester Louis Sutula and L. S. Bartell (Ames Lab., Ames, Iowa). May 1959. Contract W-7405-eng-82. 153p.

A study was made of the structure and the molecular orientation in multimolecular films of a variety of long-chain n-hydrocarbon derivatives by electron diffraction. The films were prepared by evaporating dilute solutions of the compounds or by spreading the fused compounds on polished surfaces of platinum and "chrome" plated steel. A polarimetric method was used to measure the optical thickness of the films to within a few angstrom units. Crystallites of monoclinic form were found in the multimolecular films of pure, even-numbered n-aliphatic acids, long-chain esters, and in films of n-hexacosane, n-octa-

osane and n-triacontane. Multimolecular films of pure, odd-numbered saturated n-hydrocarbons, n-octadecyl alcohol and films of some impure compounds contained crystallites of orthorhombic form. (auth)

29087 (LA-2556) THE EQUILIBRIUM COMPOSITION OF THE C/H SYSTEM AT ELEVATED TEMPERATURES. Russell E. Duff and S. H. Bauer (Los Alamos Scientific Lab., N. Mex.). June 1961. Contract W-7405-ENG-36. 174p.

Thermodynamic functions for a large number of C-H molecules were computed from estimated values of molecular parameters. These functions and others taken from the literature were used to calculate the equilibrium composition of the C/H gas phase system over the composition range $C/H = \frac{1}{10}, \frac{1}{4}, \frac{1}{2}, 1, 2, 3$. The temperature range was 500 to 5000°K, and the pressures used were 0.1, 1.0, and 10 atm. In additional calculations solid carbon was assumed to be present. Graphs of the results are presented. They show that the familiar, stable hydrocarbons are not important in characterizing the equilibrium composition above 2000°K. Acetylenic molecules and their radicals dominate the composition at high temperatures. (auth)

29088 (NAA-SR-1399(Del.)) ZIRCONIUM HYDRIDE. PART I. DISSOCIATION PRESSURE. Paul T. Gilbert, Jr. PART II. RADIATION STABILITY. Paul T. Gilbert, Jr., and Walter V. Goeddel (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 15, 1956. Decl. with deletions July 14, 1960. Contract AT-11-1-GEN-8. 170p.

A review of the chemical and physical aspects of ZrH are presented which are of particular interest in connection with its application in reactors. Experimental results on the dissociation pressure and the radiation stability of ZrH are included. An evaluation and interpretation of these data are also included. (J.R.D.)

29089 (NAA-SR-6498) HIGH TEMPERATURE REACTIONS OF THORIUM AND THORIA AND THE VAPOR PRESSURE OF THORIA. A. J. Darnell and W. A. McCollum (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 15, 1961. Contract AT(11-1)-GEN-8. 18p.

Vaporization studies on a mixture of liquid thorium and thorium dioxide were carried out in a thorium-dioxide-lined tungsten effusion cell over the temperature interval of 1984 to 2564°K. The predominant gaseous species from this reaction was identified as ThO by mass spectrometric, chemical, and evaporation studies. The pressure of ThO over the mixture was given by $\log P \text{ (atm)} = -(22,200 \pm 700)/T + (4.70 \pm 0.31)$. The solubility of ThO₂ in Th(l), determined from vacuum fusion oxygen analyses of quench samples, was 3.5 wt % ThO₂ at 2090°K and 8.2 wt % ThO₂ at 2450°K. The vapor pressure equation for ThO₂(s) was also determined by the effusion method in a tungsten cell over the temperature range of from 2268 to 2593°K. The vapor pressure equation for ThO₂(s) \rightarrow ThO₂(g) is: $\log P \text{ (atm)} = -(35,500 \pm 1100)/T + (8.16 \pm 0.47)$. Extrapolation of vaporization data for solid thorium gave the following equation for Th(l) \rightarrow Th(g): $\log P \text{ (atm)} = -27,960/T + 5.575$. However, solubility studies indicated that the partial pressures of Th and ThO₂ from a mixture of Th(l) and ThO₂(s) would be less than that obtained from the pressure equations for Th(g) and ThO₂(g). (auth)

29090 (NP-10620) QUARTERLY PROGRESS REPORT [ON POLYMERS]. Carl S. Marvel (Wright-Air Development Div. Materials Lab., Wright-Patterson AFB, Ohio). Aug. 1961. Contract AF33(616)-7908. 36p.

Progress is reported on research for production of polymeric materials which are stable at high temperatures. The work covers lattice polymers, borimidazoline polymers, spiro-pentane polymers, polyphenyl, and aromatic polyamides. (D.L.C.)

29091 (NP-10658) RESEARCH ON HIGH TEMPERATURE POLYMERS. Summary Report. I. TITANIUM AND ALUMINUM CHELATES. Technical Report No. 4. John B. Rust (Hughes Aircraft Co., Culver City, Calif.). Aug. 15, 1961. Contract Nonr 2540(00). 55p.

Investigation is reported of the synthesis of polymetalloxane polymers and copolymers containing ordered metal-oxygen-metal linkages with metals such as Al, Si, Ti, and Sn. Dichelates of Ti were prepared and examined along with monochelates of Al. In other work the properties of composite chelates prepared by combination of phenolic resins with aluminosiloxane and titanoxane polymers were examined. (J.R.D.)

29092 (ORNL-3141) DETERMINATIONS OF THE KINETICS AND MECHANISMS OF DEBORONIZATION AT 1135°C. Julian H. Cherubini (Oak Ridge National Lab., Tenn.). Sept. 15, 1961. Contract W-7405-eng-26. 104p.

The mechanisms and kinetics of the loss of boron during heating at 1135°C under various dynamic environments were determined from powder compacts of 5 wt % elemental boron dispersed in matrices of Fe, Cr, Ni, Si, Fe₂O₃, Cr₂O₃, NiO, and SiO₂, compacts of austenitic stainless steel alloy powder containing 0.25 wt % boron, and wrought specimens of 0.13 wt % boron-stainless steel alloy. The compacts containing 5 wt % boron were heat treated in vacuum, high-purity argon, wet helium, and hydrogen. With the exception of those heat treated in hydrogen, significant boron losses occurred only when a supply of oxygen, either from the sample itself or as a deliberate addition to the heat-treating environment, was available. Correspondingly, the loss mechanism is postulated to be the oxidation of boron to boron sesquioxide and its volatilization from the sample. The loss rate is controlled by the volatilization rate of the oxide which is directly influenced by structure of the compact and sintering environment. Independent of the chemical nature of the matrix, boron losses were incurred during heat treatment in hydrogen. Variations of the water content of the hydrogen from 7 to 460 ppm did not significantly influence the total boron loss observed. The synthesis of boron and hydrogen into a gaseous boron-hydrogen species is postulated as a predominating loss mechanism in a hydrogen environment. Compacts of austenitic stainless steel powder containing 0.25 wt % boron were heat treated at 1135°C from $\frac{1}{4}$ to 16 hours in hydrogen atmospheres of 3 different water vapor levels, 1, 100, and 460 parts per million. The losses observed in each environment for the first few hours of heat treatment followed the relationship: $\Delta B = 0.26t^{1/2} + C$, where ΔB is total boron loss in milligrams, t is total heat-treating time in hours, and C is a constant. However, the rate of boron loss of samples heated in the driest hydrogen decreased abruptly after two hours at temperature. Under the other environmental conditions, a similar decrease was observed after seven hours. The degree of sample sintering was found to be the predominating factor determining the boron loss rate. The rate of decrease of total sample surface area by sintering was observed to have a proportional effect in decreasing the rate of boron loss. However, the rate-controlling step in the deboronization of master alloy compacts was the rate of diffusion of gaseous reactant in and reaction products out of the sample. This in turn was controlled by the effective diameter, length, and number of channels permeating the

compact and exposed to the sintering environment. Debo-
ronization of wrought specimens was observed in both hy-
drogen (less than 15 parts per million H_2O) and helium
(15,000 parts per million H_2O). (auth)

29093 (ORO-444) SEVENTH MONTHLY PROGRESS
REPORT ON THE CHARACTERIZATION OF UO_2 POW-
DERS, MONTH OF APRIL, 1961. (Mallinckrodt Chemical
Works. Nuclear Div., Hematite, Mo.). May 31, 1961.
Contract AT(40-1)-2699. 6p.

Studies were made on the powder characterization of
twelve types of UO_2 emphasizing infrared absorption and
hot-stage microscopy techniques. A third set of pellets
was prepared using the ball-milled oxides. Carbowax-6000
was used as a binder. Analytical information is presented
in tabular form on the effect of the sintering operation on
metallic impurity levels in the pellets. (M.C.G.)

29094 (TID-13295) STUDIES ON COORDINATION
COMPOUNDS CONTAINING OLEFIN AND OLEFIN-LIKE
LIGANDS. Progress Report August 1, 1960-July 31, 1961.
Bodie E. Douglas (Pittsburgh. Univ.). July 1961. Con-
tract AT(30-1)-2274. 11p.

Activities are discussed for work conducted in the prepa-
ration and polarographic investigation of 2-allylpyridine and
olefinic carboxylic acids, and the preparation and spectro-
graphic investigation of Schiff's base complexes. (B.O.G.)

29095 (TID-13355) ORGANIC COOLANT RECLAMA-
TION. 9th Quarterly Progress Report, March 15, 1961 to
June 15, 1961. Robert J. Wineman, J. S. Adams, and D. A.
Scola (Monsanto Research Corp. Boston Labs., Everett,
Mass.). July 25, 1961. Contract AT(10-1)-1088. 28p.
(MRC-6003)

Research on reclamation methods during this quarter
covered work on fractionation, hydrocracking, partial re-
duction, product evaluation, and design and construction of
a micro pilot plant for reclamation of high boilers using
solvent distribution techniques. Various commercial petro-
leum solvents were used in solubility studies to deter-
mine whether the source of solvent varied the yield. It was
found that a higher yield of reclaimed material per gallon
of solvent can be obtained at a lower cost with a solvent
system containing some alicyclic compounds. ORME high
boiler could not be hydrocracked above $500^\circ C$ and at ele-
vated pressures because product yields were low, coke
yields were high, and catalyst life was short. The effects of
heat and hydrogen on hydrocracking were determined. At
 $500^\circ C$ and 1500 psig, hydrocracking of reclaimed high boiler
gave high product yields, low coke, and low gas yields.
Hydrocracking of partially reduced high boiler gave high
product yield, low coke, and low gas yield. Analyses of
high boiler and reclamation products for trace amounts of
oxygen using a pyrolytic technique were obtained. (M.C.G.)

29096 (TID-13586) NUCLEAR SPECTROSCOPY AND
THE APPLICATION OF RADIOISOTOPES TO THE STUDY
OF REACTION KINETICS. Progress Report No. 3, Au-
gust 1, 1960-July 31, 1961. D. C. Conway (Purdue Univ.,
Lafayette, Ind. and Purdue Research Foundation, Lafayette,
Ind.). July 31, 1961. Contract AT(11-1)-694. 25p.

The L/K-capture ratio of Zn^{66} was determined to be
 0.119 ± 0.007 . The spectrum of Si^{32} was obtained in a liquid
scintillation spectrometer and a Re compound was prepared
which it is hoped will be a good enough counting gas that the
 Re^{187} can be counted. In other work, further modifications
of the vacuum line in which ethyl iodide is pyrolyzed were
made. A review of the method used to obtain kinetic data
on ethyl iodide is included. (J.R.D.)

29097 (TID-13667) THERMOCHEMISTRY OF PRE-
CIPITATION AND "LIQUID STRUCTURE" IN MOLTEN

NITRATES. Joseph Jordan (Pennsylvania State Univ.,
University Park) and E. J. Billingham, Jr. (Thiel Coll.,
Greenville, Penna.). [Aug. 6, 1961.] Contract [AT(30-1)-
2133]. 5p.

The precipitation of $AgCl$, AgI , and $AgBr$ was studied
in molten $NaNO_3$ and KNO_3 and in eutectic melts of sodium
potassium and lithium-potassium nitrates. Results are
tabulated and illustrated graphically. (J.R.D.)

29098 (UCRL-9722) CHARGE-TRANSFER ASSOCIA-
TION AND PARAMAGNETISM OF SOME ORGANIC SYS-
TEMS. John Wesley Eastman (California. Univ.,
Berkeley. Lawrence Radiation Lab.). Aug. 1961. Con-
tract W-7405-eng-48. 102p.

When p-xylene was combined with chloranil in n-heptane
charge-transfer optical absorption was observed. The
magnitude of this absorption was used to calculate an
equilibrium constant for the formation of a donor-acceptor
complex containing one p-xylene was combined with carbon
tetrabromide and with carbon tetrachloride in n-heptane,
no charge-transfer absorption was observed. Reactions
of N,N,N',N' -tetramethyl-p-phenylenediamine (TMPD) with
chloranil ($pQCl_4$) were observed in ethylene dichloride and
acetonitrile. In both solvents adduct formation occurred
initially, as observed by its charge-transfer absorption.
In acetonitrile time-dependent electron spin resonance
(ESR) absorption was observed, and it was identified with
the positive and negative radical ions of TMPD and $pQCl_4$,
respectively. In this case a completely ionized electron
transfer had occurred. Chloranil and other quinones were
found to react with N,N -dimethylaniline forming a crystal
violet salt. The diamagnetic donor-acceptor complexes
and also semiquinone radicals are intermediates which
were observed. Some physical measurements of the ki-
netics of this reaction are described and correlated. When
fluoranil was allowed to react with dimethylaniline, the
hyperfine splitting by the fluorine atoms of the fluoranil
radical was not resolved. Characteristics of the ESR
absorption by this radical in dimethylaniline are discussed
in terms of an electron transfer between the semiquinone
and quinone, and between the semiquinone and hydro-
quinone ion. Paramagnetism was discovered in hydro-
carbon-quinone solids. ESR absorption was assigned to
imperfections in the solid which was normally diamagnetic.
The preparation of these solids and some of their physical
characteristics are described. (auth)

29099 (UR-601) EVALUATION OF FACTORS IN
THE ELUTION OF HYDROCORTISONE FROM PAPER
CHROMATOGRAMS. Frank M. Ganis, Malcolm W.
Hendrickson, Patrick D. Giunta, and Joe W. Howland
(Rochester, N. Y. Univ. Atomic Energy Project).
Aug. 21, 1961. Contract W-7401-eng-49. 17p.

An assessment was made of a number of variable factors
which affect the recovery of hydrocortisone from eluted
filter paper chromatographic fractions. Factors tested
included time of elution, sample concentration, rinsing of
eluting fractions and pre-washing of the filter paper. It
was noted that a 50 μg sample could be quantitatively re-
covered after a 15-minute elution time from a pre-washed
filter paper fraction. The results were subjected to a
statistical analysis and were found to be highly significant.
(auth)

29100 (WCAP-1689(Rev.)) THE BEHAVIOR OF
AUSTENITIC STAINLESS STEEL CORROSION PRODUCTS
IN HIGH TEMPERATURE BORIC ACID SOLUTIONS. W. D.
Fletcher, A. Krieg, and P. Cohen (Westinghouse Electric
Corp. Atomic Power Dept., Pittsburgh). Dec. 1960.
Revised May 1961. 49p.

Presented at the Tripartite Conference on Transport of Materials in Pressurized Water Nuclear Systems, Chalk River, Ont., Feb. 28, March 1, 1961.

Studies of the behavior of stainless steel corrosion products showed that boron, derived from high temperature boric acid solutions, is incorporated in synthetic corrosion products and in corrosion films. The extent of boron inclusion from high temperature boric acid solutions containing 1000 ppm B is of the order of 3 mg B per gram of synthetic finely divided corrosion product, and about 0.3 mg B per gram of stable corrosion product film. Various mechanisms for the inclusion of boron are proposed. (auth)

29101 (AEC-tr-4784) THE REACTION PRODUCTS OF PENTA-iodocarbonyl Iridiate (III) OF POTASSIUM WITH AMMONIA AND THE ALIPHATIC AMINES. Luciana Naldini. Translated for Los Alamos Scientific Lab., N. Mex., from Gazz. chim. ital., 90: 1516-21(1960). 5p.

The preparation and properties of the compounds $As(C_2H_5)_4$, $(IrCOL)_4$, $IrCOL_2I_2$, and $IrCOL_4I_2$ are described where L is used to represent ammonia or aliphatic amines both of which are weak pi binders. (J.R.D.)

29102 (AEC-tr-4786) NEW HALOGEN CARBONYL PLATINUM(II) COMPOUNDS. Lamberto Malatesta and Luciana Naldini. Translated for Los Alamos Scientific Lab., N. Mex. from Gazz. chim. ital., 90: 1505-15(1960). 10p.

Preparation of known carbonyl platinum(II) compounds and three new compounds; $(PtBr_2(CO)_2)_2$, $PtI_2(CO)_2$, and $Pt_2Br_4(CO)_3$ is described. The potassium and tetraphenylarsonium salts of the anions of trihalogen carbonylplatinates(II) were also prepared. The infrared spectra were made, and on the basis of the CO absorption rate, the structure and stability of such compounds were examined. (J.R.D.)

29103 (AEC-tr-4787) REACTION OF PLUTONIUM DIOXIDE WITH AMMONIUM HYDROGEN FLUORIDE IN THE ABSENCE OF WATER. Ya. (Ia.) Maly, I. Peka, M. Talash, and M. Tympl. Translated by Helen J. Chick and Robert Benz for Los Alamos Scientific Lab., N. Mex. from Radiokhimiya, 3: No. 2, 195-8(1961). 11p.

Plutonium tetrafluoride was prepared by the decomposition of a mixture of PuO_2 and NH_4HF_2 by heating in the absence of water. The suspended quantity of PuO_2 was mixed in a platinum crucible with a 20 to 50% stoichiometric excess of recrystallized and dried NH_4HF_2 and then heated to 350°C. Besides analytical determinations, the resulting compound was also inspected by x-ray methods. The thermal stability and structure of the intermediate and final products were studied. (M.C.G.)

29104 (AEC-tr-4810) THERMAL DECOMPOSITION OF THE PERCHLORATES OF MAGNESIUM, CALCIUM, BARIUM, AND ALUMINUM. A. A. Zinov'ev (Zinov'yev) and A. I. Chudinova. Translated from Zhur. Neorg. Khim., 1: 1722-30(1956). 14p.

The data were obtained by the differential-thermal method. The solid decomposition residues were analyzed for bound chlorine and for the cation content in the perchlorates. The polytherm of O liberation was also recorded. It was concluded that decomposition of the perchlorates of Mg, Ca, and Ba take place exothermically while that of Al takes place endothermically. (J.R.D.)

29105 (AEC-tr-4815) PREPARATION OF DISULFAMIDE IMIDE AND SOME OF ITS DERIVATIVES. M. Bousquet and M. O. Gryszkiewicz-Trochimowski. Translated by Myra Scott Feldman (Savannah River Lab.,

Aiken, S. C.) from Bull. soc. chim. France, No. 10 1543-4 (1959). 12p.

A method of disulfamide imide preparation is described which consists of the decomposition of the disulfamide silver salt by H_2S which is obtained from partial hydrolysis of sulfamide by silver nitrate. The methods for use with salts of sodium, potassium and the methyl derivatives are also described. (J.R.D.)

29106 (AERE-Trans-863) RESEARCH ON THE PRODUCTION OF URANIUM MONOCARBIDE. T. Sano. S. Imoto, and Y. Takada. Translated by S. C. Brickley for U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng. from Nippon Genshiryoku Gakkaishi, 1: 425-32(1959). 17p.

Studies were made on the process of producing pure UC powders by preparing UH_3 , decomposing UH_3 to U, and reacting U with C_2H_2 at 700 to 750°C. The effects of pressure, C_2H_2 volume, temperature, etc., on the process were investigated. The reaction mechanism was elucidated. (D.L.C.)

29107 (JPRS-10041) THE DISTRIBUTION OF THE RARE-EARTH ELEMENTS IN THE HYDROLYSIS OF ALLOYS OF THEIR OXIDES WITH AMMONIUM THIOCYANATE. V. K. Val'tsev and E. (Ye.) D. Oziashvili. Translated from Izvest. Sibir. Otdel. Akad. Nauk S.S.S.R., No. 6, 59-64(1960). 11p.

Rare earth oxide mixtures containing high concentration levels of Nd and Y—Er oxides were fused with ammonium thiocyanate and then hydrolyzed in water, and the coefficients of the distribution of the oxides between insolubles and solution were determined. The results were applied to the fractionation of one Nd concentrate and two Y—Er concentrates. (D.L.C.)

29108 (UCRL-Trans-706) DISSOCIATION ENERGIES OF OXIDES OF MAGNESIUM, CALCIUM, STRONTIUM, AND BARIUM. I. V. Veits and L. V. Gurvich. Translated by D. A. Nimidoff for Univ. of California Lawrence Radiation Lab., Berkeley, from Optika i Spektroskopiya, 1: 22-33(1956). 22p.

Results of experiments are presented in which the dissociation equilibrium constant of the oxides of Mg, Ca, Sr, and Ba were obtained. The partial pressures of the metals were measured in a flame of known temperature in which a salt solution of the test metal was fed. From these data calculations were made. Resulting data are tabulated. (J.R.D.)

29109 (UCRL-Trans-708) ON THE DISSOCIATION ENERGIES OF MOLECULES OF THE OXIDES OF THE ALKALINE EARTH ELEMENTS. I. V. Veits and L. V. Gurvich. Translated by D. A. Nimidoff (Univ. of California Lawrence Radiation Lab., Berkeley) from Zhur. Fiz. Khim., 31: 2306-9(1957). 16p.

Measurement results of CaO and SrO dissociation energies are presented. The data were obtained by measuring the equilibrium constant of dissociation reaction in $CO + O_2$ flames where the partial pressures of the hydroxyl radicals are much lower than in other flames at about 3000°K. (J.R.D.)

29110 (UCRL-Trans-710) THE MEASUREMENT OF EXTREMELY SHORT DISSOCIATION TIMES OF ORGANIC IONS WITH THE FIELD IONIZATION MASS SPECTROMETER. H. D. Beckey. Translated by Amos S. Newton for Univ. of California Lawrence Radiation Lab., Berkeley from Z. Naturforsch., 16a: 505-10(1961). 16p.

With the help of a field emission ion source in combination with a mass spectrometer, very short dissociation

times of organic ions were measured up to minimum values of a few times 10^{-14} sec. Examples of such short dissociation times were found as yet only with organic ions, though the method is not limited to organic materials, but can be used to measure all ion dissociation times lying between 10^{-14} and 10^{-7} sec. By this method the range of the mass spectroscopic measurement of the lifetime of ions is extended several powers of ten compared to the electron impact method. The relation between the dissociation times of ions and the broadening of the lines in the mass spectrum was theoretically derived. Preliminary experiments of the dissociation of butane and neopentane confirmed the practicability of the field ionization method for the measurement of extremely short dissociation times: lifetimes of the parent ions of about 5×10^{-14} sec were found. (auth)

29111 THE THERMODYNAMICS OF THE REDUCTION OF THORIUM DIOXIDE BY CALCIUM. Yu. I. Zarembo. *Atomnaya Energ.*, 11: 185-6 (Aug. 1961). (In Russian)

On the basis of available thermodynamic data the ΔZ_T^0 and the log K data were calculated for the reaction $\text{ThO}_2 + 2 \text{Ca} = \text{Th} + 2 \text{CaO}$ for the following temperature ranges: 298-713, 713-1123, 1123-1760 and beyond 1760°K. The results were also presented as a function of the variation of the isotherm-isobar potential. The calculations show that at 1000 to 1100°K which is the optimum temperature range for calciothermic reduction of ThO_2 , the reaction shifts nearly completely toward the side of the $\text{Th} + \text{CaO}$ formation. The reduction can take place only at temperatures below 1760°K, the boiling point of Ca. (TTT)

29112 VISIBLE SPECTRA OF XeO AND KrO . C. Dewey Cooper, G. C. Cobb, and E. L. Tolnas (Univ. of Georgia, Athens). *J. Mol. Spectroscopy*, 7: 223-30 (Sept. 1961).

When traces of oxygen are added to one atmosphere of xenon or krypton in a discharge tube, characteristic spectra near the 5577 Å ($^1\text{S}_0 - ^1\text{D}_2$) line are observed for each mixture. These spectra are associated with rare gas oxygen molecules which may be formed with oxygen in the $^1\text{S}_0$ or $^1\text{D}_2$ state. The vibrational bands of the XeO spectrum may be represented by: $\nu = 20097 + 142 \nu' - 9.9 \nu'^2 + 0.1 \nu'^3 - (360 \nu' - 12.0 \nu'^2) \text{ cm}^{-1}$. Many of the rotational lines were resolved, but the overlapping of bands prevented a complete rotational analysis. (auth)

29113 RÖNTGENOGRAPHISCHE CHEMIE. Möglichkeiten und Ergebnisse von Untersuchungen mit Röntgen und Elektroneninterferenzen in der Chemie. (Roentgenographic Chemistry. Potentialities and Results of Research with X-Ray and Electron Interference in Chemistry). E. Brandenberger and W. Epprecht. Basel and Stuttgart, Birkhäuser Verlag, 1960. 272p.

Investigations were made of x-ray and electron interference in crystals and its use in chemical analyses. Topics covered include the characteristics of crystals, methods for roentgenographic investigation of crystalline materials, crystalline and amorphous phases, x-ray interference as characteristics of crystalline form, roentgenographic qualitative analysis and examinations of entire systems, x-ray interference as a characteristic of the state of the crystal, x-ray interference as a means for studying transformations and chemical reactions in stable states, x-ray and electron interference as a characteristic of the constituents of solid bodies, and crystal structure determinations with x rays. (M.C.G.)

Analytical Procedures

29114 (AERE-R-3716) A METHOD FOR ROUTINE DETERMINATIONS OF TRITIUM IN URINE USING A

COINCIDENCE LIQUID SCINTILLATION COUNTER.

J. Sandalls (United Kingdom Atomic Energy Authority, Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). June 1961. 15p.

A sensitive and wide range method for the routine measurement of tritium in urine is described. Urine, distilled in the presence of toluene, is assayed for tritium content by a liquid scintillation technique. Two 1-in. diameter matched E.M.I. type 9524S/A photomultiplier tubes are connected through coincidence and discriminator units to a standard amplifier and scaler. The liquid scintillation counting is carried out at room temperature. A tritium concentration of $1 \times 10^{-3} \mu\text{c/ml}$ in urine gives about 160 cpm above a background of about 170 cpm. The counting efficiency is 7%. The absolute limit of detection of the method for tritium in urine is about $1.6 \times 10^{-4} \mu\text{c/ml}$, on the basis of two standard deviations. (auth)

29115 (AERE-R-3772) CONTROLLED-POTENTIAL COULOMETRY IN METALLURGICAL ANALYSIS. G. W. C. Milner and J. W. Edwards (United Kingdom Atomic Energy Authority, Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1961. 31p.

The suitability of controlled-potential coulometry for problems in metallurgical analysis was investigated. Details are given of some analytical applications of a new coulometer developed at AERE, and the principles of the instrument and the technique are discussed. This technique was used for the accurate determination of Pu, mainly in binary alloys with U covering the range from 0.1 to ~12% Pu. Details are given of a coulometer cell which uses an ion exchange membrane to separate the main compartment from the auxiliary and reference electrode compartments. (auth)

29116 (BLG-56) DETERMINATION DU POTASSIUM DANS L'ORGANISME. (Determination of Natural Potassium in the Body). P. A. Delwaide, J. F. Colard, G. Verly, and R. R. Boulenger (Brussels. Centre d'Etude de l'Energie Nucleaire). May 15, 1961. 9p.

The amount of natural potassium in the body was determined by measuring the gamma radiation of K^{40} , natural radioactive isotope, with a total body counter. This counter worked with a 8 in. dia \times 4 in. height NaI crystal, placed in a shielded room to reduce the background, and a 256 channel analyzer. Ten men were measured, and again 24 hours after administration of a small accurately known amount of K^{42} used for the calibration. This isotope has characteristics quite identical to those of K^{40} . The observed potassium amounts were between 1.77 g/kg and 2.15 g/kg. The accuracy and reproducibility of these measurements are 3%. (auth)

29117 (BMI-1538) DETERMINATION OF OXYGEN IN SODIUM AT CONCENTRATIONS BELOW 10 PPM. Daniel R. Grieser, George G. Cocks, Elton H. Hall, William M. Henry, and John McCallum (Battelle Memorial Inst., Columbus, Ohio). Aug. 23, 1961. Contract W-7405-eng-92. 38p.

New approaches to the problem of oxygen detection in sodium were evaluated. Although refinement of plugging-indicator, vacuum-distillation, and electrical-resistivity techniques was attempted to make them suitable for use as possible calibration and monitoring techniques, major effort was on the experimental evaluation of novel, non-chemical approaches promising discrimination for oxygen among the total impurities normally encountered in sodium. Empirical studies were made to determine the applicability of ellipsometry, polarography, coulometry,

mass spectrometry, and arc emission spectrography as low-level oxygen-in-sodium detection methods. Recent attempts to demonstrate the feasibility of these approaches were unsuccessful; however, none appears technically impossible. Lack of success was attributed mainly to possible interference of impurities other than oxygen and lack of precise standards or an accurate calibration technique. Additional development of coulometry as a potential oxygen-monitoring technique and arc emission spectrography as a laboratory calibration technique having the potential capacity to distinguish and measure many impurities in addition to oxygen seems justified. Electrorefining appears promising as a method of producing ultrapure sodium standards for impurity-detection development studies. (auth)

29118 (CLOR-6) PRACTICAL METHOD OF THE RADIOACTIVE AIR CONTAMINATION DETERMINATIONS IN THE SELF-LUMINOUS ITEMS ESTABLISHMENTS. R. Szepeke, T. Wardaszko, and J. Pensko (Poland. Biuro Pełnomocnika Rządu do Spraw Wykorzystania Energii Jadrowej. Centralne Laboratorium Ochrony Radiologicznej, Warsaw). Jan. 1961. 22p.

Measurements were made of radioactive air-borne contamination in establishments where unsealed sources containing natural elements of the radium and thorium series are used. The dust activity collected on filter paper was analyzed in a manner permitting determination of the concentration of short-lived and long-lived alpha and beta-emitters in the air. The ventilation efficiency influence on the equilibrium conditions is discussed. The method was checked in a number of factories using self-luminous paints. (auth)

29119 (CNI-55) DETERMINAZIONE PER COULOMETRIA INTERNA DI OSSIGENO DISCIOLTO IN ACQUA. (Internal Coulometric Method for Oxygen Dissolved in Water). G. Barbi and S. Sandroni (Italy. Comitato Nazionale per L'Energia Nucleare, Ispra). Oct. 1960. 18p.

An internal coulometric method for the determination of small quantities of oxygen dissolved in water was developed. It is based on the measurement of the total charge supplied by a couple of platinum copper electrodes submerged in a solution containing cuprous ammonium salt and ammonia. The results reported show the possibility of measuring oxygen content in water and hydrogen peroxide with an accuracy of $\pm 5\%$. (auth)

29120 (DP-610) DETERMINATION OF ENRICHED URANIUM IN PROCESS WASTE STREAMS. Myron O. Fulda (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Aug. 1961. Contract AT(07-2)-1. 9p.

An indirect colorimetric method, adaptable to in-line application, was demonstrated for the measurement of enriched uranium in waste from tributyl phosphate solvent extraction processes. The maximum absolute error from process variables was 10^{-6} M uranium over a uranium concentration range of 10^{-6} to 10^{-5} M. The necessary sensitivity for the analysis of waste containing this low concentration of uranium was obtained by selecting as the sample the organic solvent in contact with the aqueous waste. (auth)

29121 (HW-69511) DETERMINATION OF RADIO STRONTIUM BY ION EXCHANGE. F. P. Roberts (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 15, 1961. Contract AT(45-1)-1350. 8p.

The separation of strontium from impurities was ob-

tained by passing the sample diluted in 0.1M HCl through an anion exchange column and a cation exchange column in series. The anion exchanger absorbed the Zr^{85} and Nb^{95} . The cation exchange column which absorbed the strontium was washed with ammonium alpha hydroxy-isobutyrate to remove the rare earths, Y, Ru, and Cs. The Y^{90} was allowed to grow in and again was eluted and counted to determine Sr^{90} . The strontium was then eluted to determine Sr^{89} and Sr^{90} . Strontium yields were greater than 99% and radiochemical purity was excellent. (auth)

29122 (IDO-14558) SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN HAFNIUM. B. E. Ginther and G. V. Wheeler (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Aug. 25, 1961. Contract AT(10-1)-205. 11p.

A spectrographic method using d-c arc excitation in a controlled atmosphere was developed to analyze for seven impurity elements in radioactive hafnium samples. Analysis requires as little as 35 mg of hafnium oxide. (auth)

29123 (NDA-2154-6) EXPERIMENTAL DETERMINATION OF CONTAMINANTS IN SODIUM. H. Steinmetz and B. Minushkin (United Nuclear Corp. Development Div., White Plains, N. Y.). Aug. 30, 1961. Contract AT(30-1)-2303. 39p.

An analytical method for the determination of oxygen in sodium was developed. The sodium was amalgamated with mercury and removed from the sodium oxide. The sodium oxide was then dissolved in an alcohol and finally reacted with an organic acid. The sodium oxide was thereby converted into an equivalent amount of water. This water was then titrated with Karl Fischer reagent. The method has the advantage of not requiring a complete separation of the sodium from the sodium oxide. The method was checked with samples containing known amounts of oxygen. The analysis of a series of samples of zirconium-gettered sodium gave a mean value of 3 ppm of oxygen with a standard deviation of ± 1.5 ppm. Three samples of sodium were analyzed for their carbon contents by a wet combustion method. The method used and the analytical results are described. (auth)

29124 (PWAC-352) THE PURIFICATION AND GAS CHROMATOGRAPHIC ANALYSIS OF HELIUM. J. Malgolio, E. A. Limoncelli, and R. E. Cleary (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). June 30, 1961. Contract AT(11-1)-229. 44p.

Titanium sponge at elevated temperatures and activated carbon at liquid air temperature were evaluated as purification materials for noble gases. Design parameters for large scale purifiers were formulated. Gas chromatographic techniques were developed and used to analyze effluent purifier gases for contaminants with a sensitivity of about one part per million. (auth)

29125 (TID-7015(Suppl.3)) OAK RIDGE NATIONAL LABORATORY MASTER ANALYTICAL MANUAL. (Oak Ridge National Lab., Tenn.). June 1961. 708p.

Forty-four new methods and 12 revised methods to be added to the ORNL Master Analytical Manual are presented. Included are ionic, radiochemical, spectrographic, nuclear, and process analysis methods. (M.C.G.)

29126 (TID-7612(p.239-59)) STUDIES OF LOW-LEVEL LIQUID SCINTILLATION COUNTING OF TRITIUM. W. J. Kaufman, G. Parks (California. Univ., Berkeley. Div. of Hydraulic and Sanitary Engineering) A. Nir (California. Univ., Berkeley. Lawrence Radiation Lab.) and R. M. Hours (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay).

A counting system was developed which allows detection of tritium in concentrations of 10^{-8} $\mu\text{c}/\text{ml}$ or less with a counting period of no more than 30 min. A dioxane-naphthalene-water scintillator with PPO and POPOP solutes was selected for use with the Tri-Carb counter. Studies were made to determine the performance of the Tri-Carb for tritium counting, and the use of a Co^{57} standard as a counting efficiency monitor was examined. (D.L.C.)

29127 (AERE-Trans-869) THE DETERMINATION OF RADIOISOTOPES IN URINE. K. E. Schulte and G. Henke. Translated by A. Schoenfeld for U.K.A.E.A. Atomic Energy Research Establishment from Deut. Apotheker Ztg., 100: 700-6(1960). 20p.

The use of radiochemical analysis of the urine for estimating the intentional or undesirable intake of radioisotopes is discussed. If the radioactive substance is known, chemical identification of the nuclides is not necessary and they can be quantitatively determined by an activity check after extraction from the urine. If the cause and type of contamination are unknown, the total activity must be determined, and a qualitative radiochemical analysis must be made, followed by a quantitative determination of the identified isotopes. Various methods for determining the presence and amount of radioisotopes in urine are discussed. (M.C.G.)

29128 A RAPID ANALYTICAL METHOD FOR THE DETERMINATION OF BERYLLIUM IN AIR SAMPLES. R. A. Hiser, H. M. Donaldson, and C. W. Schwenzfeier (Brush Beryllium Co., Elmore, Ohio). Am. Ind. Hyg. Assoc. J., 22: 280-5(Aug. 1961).

A method is described which consists of sample collection on Whatman #41 filter paper, ashing of the sample, and subsequent conversion to beryllium fluoride. The formation of a lake with p-nitrophenylazoarcinol, and comparison of the Klett reading with a standard curve gives beryllium content. (For optimum results, samples should contain from 5 to 45 micrograms of beryllium.) Interfering heavy metals are chelated with Dow's Versene "T". Copper and zinc are complexed with cyanide. The method is recommended only for air samples collected on Whatman #41 paper or equivalent. (auth)

29129 NEUTRON ACTIVATION ANALYSIS FOR U^{235} , ESPECIALLY IN LIMESTONES, BY MEASUREMENT OF Xe^{133} . Larry A. Haskin, Harold W. Fearing, and F. S. Rowland (Univ. of Kansas, Lawrence). Anal. Chem., 33: 1298-1301(Sept. 1961).

In order to determine uranium concentrations in limestone sediments selected for geologic dating by the thermoluminescence method, a new procedure for uranium analysis by neutron activation was developed. The 5.27-day Xe^{133} , formed by the thermal neutron fission of U^{235} , is isolated from most fission product contamination by combustion of the limestone with tantalum. It is then separated from other noble gases by gas chromatography, and assayed by gas proportional counting. This technique, suitable for general application to uranium in most materials, is sensitive to approximately 10^{-10} gram with a precision of $\pm 4\%$. The technique can be adapted readily for other neutron activation analyses which involve measurement of noble gas radioactivities. (auth)

29130 RADIOCHEMICAL DETERMINATION OF ISOTOPIC THORIUM IN URANIUM PROCESS STREAMS. Henry G. Petrow, Bernard Sohn, and Robert J. Allen (Ionics, Inc., Cambridge, Mass.). Anal. Chem., 33: 1301-3(Sept. 1961).

The determination of thorium in uranium mill effluents

requires an accurate sensitive method, free of interference from cationic and anionic impurities. The method developed is valuable to the determination of natural thorium and thorium-230, and can be adapted to allow for the determination of other thorium isotopes. Sensitivity and accuracy are good, and only titanium interferes sufficiently to require modification of the procedure. The method can be used for aqueous and solid samples and only conventional counting equipment is required. (auth)

29131 ESTIMATION OF THE ISOTOPIC COMPOSITION OF SEPARATED RADIUM SAMPLES. Henry G. Petrow and Robert J. Allen (Ionics, Inc., Cambridge, Mass.). Anal. Chem., 33: 1303-5(Sept. 1961).

The isotopic spectrum of radium samples separated from uranium mill effluents is such that a simple technique capable of estimating the concentration of each nuclide is required. A technique capable of determining radium-223, radium-224, radium-226, and radium-228 was developed. Radium-226 is determined by differences; the others are determined by chemical separation and counting of daughter activities. The method is sensitive to low concentrations of activity, approximately 40 dpm per liter, and is free from interference from other natural activities. The technique permits the rapid estimation of radium nuclides and does not require the use of elaborate or specialized equipment. (auth)

29132 DETERMINATION OF STRONTIUM-90 IN MILK BY AN ION EXCHANGE METHOD. Charles Porter, Daniel Cahill, Roger Schneider, Philip Robbins, Wilford Perry, and Bernd Kahn (Southeastern Radiological Health Lab., Montgomery, Ala.). Anal. Chem., 33: 1306-8(Sept. 1961).

A simple and rapid method was developed for measuring low concentrations of strontium-90 in milk, with an estimated standard deviation of 1 μc per liter in the 1- to 20- μc per liter range. A liter of milk is passed successively through cation exchange resin, to remove the alkaline and alkaline earth ions, and through anion exchange resin, which retains the yttrium-90 daughter of strontium-90. The yttrium is eluted with dilute hydrochloric acid, precipitated as the oxalate, and counted in an anti-coincidence beta counter. Good agreement is found between this method and a previously established method. (auth)

29133 GAMMA-RAY ABSORPTIOMETER FOR DETERMINATION OF URANIUM IN AQUEOUS AND ORGANIC SOLVENT SOLUTIONS. S. J. Broderick and J. C. Whitmer (U. S. Atomic Energy Commission, New Brunswick, N. J.). Anal. Chem., 33: 1314-17(Sept. 1961).

A γ -ray absorptiometer was constructed containing 250 mg of americium-241 source, an ionization chamber filled with xenon gas, a vibrating-reed electrometer as amplifier, and a recorder to record the measurements. The absorption of γ rays by aqueous and organic solutions of uranium in the range 1 to 550 grams of uranium per liter was measured. The sensitivity of the method is better than 1% in the higher ranges of uranium content, and less than 0.5 gram of uranium per liter can be detected. (auth)

29134 THE RAPID DETERMINATION OF SULFUR IN PETROLEUM FRACTIONS BY X-RAY ABSORPTION OF TRITIUM BREMSSTRAHLUNG. A. F. Pyrah, R. S. Robertson, and Jeffrey Wiseman (Mobil Oil Co., Ltd., Coryton, Essex, Eng.). Anal. Chem., 33: 1355-60(Sept. 1961).

The bremsstrahlung emission from a tritium-titanium source is utilized in a rapid method for the estimation of sulfur in petroleum products. The calibration procedures described were developed to compensate for the polychromatic nature of the x rays. Products ranging from gas oils to heavy fuel oils, containing up to 5% sulfur, can be tested

conveniently using relatively inexpensive equipment. Time per test is about 6 minutes, including calculation. The method commends itself to laboratories carrying out frequent sulfur determinations by semiskilled staff. Accuracy and repeatability are of the order of 0.05% sulfur. (auth)

29135 DETERMINATION OF SODIUM, POTASSIUM AND PHOSPHORUS IN BIOLOGICAL MATERIAL BY RADIOACTIVATION. H. J. M. Bowen and P. A. Cawse (Wantage Research Lab., Berks, Eng.). *Analyst*, 86: 506-12 (Aug. 1961).

Neutron-activation analysis was applied to the determination of sodium, potassium, and phosphorus in biological material. When a flux of 10^{12} neutrons per sq cm per second for activation and an anti-coincidence counting unit were used, the ultimate limits of sensitivity for the three elements were approximately 10^{-10} , 10^{-9} , and 10^{-10} g, respectively. Radiochemical separation procedures were used, and it was possible to analyze eight samples for all three elements in an 8-hour working day. (auth)

29136 THE SPECTROCHEMICAL ANALYSIS OF MAGNESIUM AND ITS ALLOYS FOR BERYLLIUM, LEAD, AND OTHER TRACE ELEMENTS BY SOLUTION AND SALT-CAP TECHNIQUES. R. E. Mansell (Dow Chemical Co., Midland, Mich.). *Appl. Spectroscopy*, 15: No. 3, 70-2 (1961).

Spectrographic solution and salt-cap techniques are described for the determination of beryllium, lead, and other trace elements in magnesium alloys in the range 0.0001-0.3%. Beryllium is determined with a precision within $\pm 4\%$ between 0.0001 and 0.01% with a high voltage spark source and a rotating disk electrode method. Comparative sensitivity and precision results are given for Al, Ca, Cu, Fe, Mn, Pb, Ni, Sn, and Zn with a high voltage spark condition using the rotating disk electrode and an a-c arc salt-cap technique. Considerable improvement in sensitivity for Al, Ca, and Pb is demonstrated with use of an argon atmosphere in the a-c arc work. (auth)

29137 ESTIMATION OF LEAN MEAT CONTENT OF HAMS BY K^{40} MEASUREMENTS. A. Pfau, G. Kallistratos, and J. Schröder (Max-Planck-Institut für Tierzucht und Tierernährung, Mariensee, Ger.). *Atompraxis*, 7: 279-84 (Aug. 1961). (In German)

The gamma activities of intact and separated hams from hogs brought up at the experimental field station at Mariensee and slaughtered in spring 1960 are determined by external counting. The potassium content due to the K^{40} activity is compared with those obtained by flame photometric analysis. The results indicate a high reliability of the non-destructive lean meat estimation of hams by K^{40} measurements. (tr-auth)

29138 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM WITH SODIUM 2', 6'-DICHLORO-4'-HYDROXY-3, 3'-DIMETHYLFUCHSONE-5, 5'-DICARBOXYLATE. Yukiteru Katsube, Katsuya Uesugi, and John H. Yoe (Himeji Technical Inst., Himeji, Japan and Univ. of Virginia, Charlottesville). *Bull. Chem. Soc. Japan*, 34: 826-9 (June 1961). (In English)

A procedure was developed for the spectrophotometric determination of small amounts of uranium with sodium 2', 6'-dichloro-4'-hydroxy-3, 3'-dimethylfuchstone-5, 5'-dicarboxylate. Beer's law is obeyed up to about 9 γ of uranium per milliliter. The accuracy and precision are satisfactory and interference of foreign ions is eliminated by using an anion exchange resin. (auth)

29139 RADIOACTIVE METHODS OF ANALYSIS. J. Laverlochere and P. Martinelli. *Bull. inform. sci. et tech.* (Paris), No. 51, 50-7 (May 1961). (In French)

Five types of radioactive methods of analysis are briefly described: activation analysis, x-ray fluorescence analysis, absorptiometric analysis, analysis by back-scattering of nuclear radiation, and the Chleck and Ziegler method of radiometric analysis. The sensitivities for thermal neutron activation for an irradiation time of 6 min are tabulated for a number of isotopes. (J.S.R.)

29140 THE DETERMINATION OF RELATIVE ABSORPTION COEFFICIENTS BY THE METHOD OF ISOTOPIC DILUTION. G. V. Isagulyants, A. A. Balandin, and E. I. Popov. *Doklady Akad. Nauk S.S.S.R.*, 139: 139-41 (July 1, 1961). (In Russian)

The determination of relative absorption coefficients is important in estimating the binding energies in catalysts and in studying catalytic processes. A mixture of an alcohol and an ether which are tagged with C^{14} can be absorbed on aluminum oxide, and then removed by eluting with a mixture of the inactive components. The amounts of alcohol G_1 and of ether G_2 can be determined from these experiments, and are related to the absorption coefficients by the following simple relation: $G_2/G_1 = G_2^m P_2 b_2 / G_1^m P_1 b_1 = G_2^m P_2 z^1 / G_1^m P_1$, where G_1^m and G_2^m are the amounts of alcohol and ether required to cover the surface with a monomolecular layer, P_1 and P_2 are the partial pressures of alcohol and ether, b_1 and b_2 are the absorption coefficients, and z^1 is the relative absorption coefficient. This method can also be used to study the absorption of a mixture also. It was shown that the tagged alcohol and ether were completely removed from the column of aluminum oxide. The relative absorption coefficient z^1 was found to be 0.04 which agreed closely to a value obtained from the literature by extrapolation. (TTT)

29141 THE APPLICATION OF THE (α, n) NUCLEAR REACTION IN DETERMINING A NUMBER OF ELEMENTS IN SOLUTION. I. N. Plaksin, M. A. Belyakov, V. L. Rentyrgin, and L. P. Starchik. *Doklady Akad. Nauk S.S.S.R.*, 139: 424-6 (July 11, 1961). (In Russian)

The (α, n) reaction has a high yield for Be (80 neutrons per $10^6 \alpha$ particles), B (24 neutrons per $10^6 \alpha$ particles) and F (12 neutrons per $10^6 \alpha$ particles). Other elements such as Li, Si, Al, C, and O have significantly lower yields of 2.5, 0.74, 0.16, 0.11, and 0.07 neutrons per $10^6 \alpha$ particles, respectively. Solutions of $BeSO_4$ in water and of boric acid dissolved in KOH were placed in a cuvette with a thin mica bottom (1.8 mg/cm^2), and irradiated from the top and through the bottom with alpha particles from a 30-mc source of Po^{210} . A B^{10} counter set in a paraffin block was used to detect the fast neutrons emitted as a result of the (α, n) reaction. The neutron count rate was found to be a linear function of the concentrations of Be and B in solution. The effect of a fluoride impurity can be subtracted to obtain the true concentration of Be or B. Boron and cadmium which have large capture cross sections for neutrons do not affect the results of the analysis if a small amount of solution is used, since the fast neutrons formed in the (α, n) reaction can still escape and be counted by the neutron detector. Only 1 ml of solution is required in order to obtain uniform irradiation of the sample. Direct irradiation of the solution from the top gives a higher neutron count rate. Increasing the size of the alpha source to 1 curie of Po^{210} would increase the sensitivity of the method. (TTT)

29142 SELECTIVE RADIOACTIVATION AND MULTIPLE COINCIDENCE SPECTROMETRY IN THE DETERMINATION OF TRACE ELEMENTS IN BIOLOGICAL MATERIAL. MEASUREMENT OF MANGANESE. D. C. Borg, R. E. Segel, P. Kienle, and L. Campbell (Brookhaven Na-

tional Lab., Upton, N. Y.). Intern. J. Appl. Radiation and Isotopes, 11: 10-29(Aug. 1961). (BNL-5012) (In English)

Coincidence spectrometric techniques frequently can resolve the radiations from complicated mixtures of radioisotopes by capitalizing on differentiating characteristics of the pertinent decay schemes. When isotopes with distinctive β - γ decay chains are selected for detection, scintillation spectrometry may be employed. Then the γ spectrum from a NaI(Tl) crystal can be recorded by a multichannel pulse-height analyzer that is gated by a coincidence circuit when it simultaneously receives signals from the γ -counter and from a β scintillation spectrometer. When used in this way, the power of a two-crystal β - γ detector to resolve a single β - γ decay branch is limited by the γ response of the β sensing element, which thus records interfering γ - γ cascades. A marked improvement in selective β - γ discrimination is provided by a three-crystal coincidence geometry, where an additional plastic or anthracene crystal (which is so thin as to have negligible γ sensitivity) is placed in front of the thicker crystal of the β spectrometer to distinguish β from γ rays. When radiometric analysis is applied to neutron-activated sources, detection of certain nuclides with low-energy (n, γ) resonances (e.g. Mn^{55} , Co^{59}) may be further enhanced relative to other isotopes without such resonances (e.g. Na^{23} , Cl^{37}) by irradiating with resonance neutrons. In an example of neutron activation analysis of manganese, selective activation with a filtered reactor neutron spectrum and triple coincidence spectrometry were combined. The former enhanced the ratios of Mn^{56}/Na^{24} and Mn^{56}/Cl^{38} activation to about seven times and fifteen times, respectively, the values produced by thermal neutrons; while the latter suppressed by a factor of about 100 the interference due to Na^{24} in the detection of Mn^{56} by γ spectrometry. In this way, manganese in blood plasma may be measured without recourse to radiochemical separations. (auth)

29143 A SIMPLE DEVICE FOR THE RAPID ROUTINE LIBERATION AND TRAPPING OF $C^{14}O_2$ FOR SCINTILLATION COUNTING. G. Moss (Albany Medical Coll., N. Y.). Intern. J. Appl. Radiation and Isotopes, 11: 47-8(Aug. 1961). (In English)

The design of a simple device for the rapid routine production of $C^{14}O_2$, and its simultaneous entrapment within the vial used for scintillation counting in one rapid step, is described. To cite on example, the device is utilized in metabolic studies where $C^{14}O_2$ is examined as one of the end products. Experimental results from this device show that five samples of $C^{14}O_3^{2-}$ solutions, 3 aqueous and 2 plasma, containing 40,000 dpm of C^{14} , showed quantitative recovery with an average deviation of 1.2%. The counting efficiency for the test averaged 66%. (N.W.R.)

29144 RADIOCHEMICAL DETERMINATION OF PLUTONIUM IN THE JRR-1 IRRADIATED URANIUM. Kenju Watanabe (Japan Atomic Energy Research Inst., Tokyo). J. At. Energy Soc. Japan, 3: 497-501(July 1961). (In German)

Small amounts of plutonium were determined radiochemically after separating plutonium from uranium and fission products by the ion exchange methods. A 7 N nitric acid solution of irradiated uranium was passed through the anion exchange resin, Dowex 1. Uranium and fission products were washed out with 7 N nitric acid, while the nitrate complex of plutonium (IV) was adsorbed on the resin bed. Plutonium was eluted with 5% hydroxylamine hydrochloride solution. The solution containing both plutonium and hydroxylamine was passed through the cation exchange resin, Dowex 50, in order to remove the hydroxylamine. After washing the resin with 0.3 N nitric acid, plutonium

was eluted with 7 N nitric acid. The synthetic samples containing 2 ~ 200 mg of uranium and 0 ~ 4500 dpm of Pu^{239} were treated by the above method in order to determine the interference of uranium content on the recovery of plutonium. The recovery of plutonium, ~92%, is not affected practically with less than 200 mg of uranium. Amounts of plutonium in uranium samples irradiated 66.5 hr in experimental hole No. 2N of JRR-1 and 194 hr in experimental hole No. 13 were 79 dpm $Pu^{239}/mg U^{238}$, respectively. 4890 dpm $Pu/mg U^{238}$ was found in uranium irradiated for 50000 kwh in JRR-1. (auth)

29145 NEPTUNIUM-237 IN JRR-1 FUEL SOLUTION. Eiko Nakamura (Japan Atomic Energy Research Inst., Tokyo). J. At. Energy Soc. Japan, 3: 502-6(July 1961). (In English)

A fuel solution of 20% enriched uranium was taken out from JRR-1 after 5×10^4 kwh operation for chemical analyses. From this solution, neptunium was separated by combined solvent extraction and anion exchange techniques. According to the alpha-spectrometric study, the neptunium fraction contained only Np^{237} . (auth)

29146 STUDIES ON SOME LESS FAMILIAR FERROCYANOGEN COMPLEXES. PART IV. SPECTROPHOTOMETRIC AND CONDUCTOMETRIC STUDIES ON BERYLLIUM FERROCYANIDE. Wahid U. Malik (Aligarh Muslim Univ., India). J. Indian Chem. Soc., 38: 293-6(May 1961). (In English)

The reaction between potassium ferrocyanide and beryllium chloride was studied spectrophotometrically. From the results it is concluded that decomposition of K_4FeCy_6 is a slow reaction, the reaction is dependent on the concentration of beryllium ions, and it can best be studied at 450m μ . Appearance of the blue color in the slightly acidic solution of potassium ferrocyanide in the presence of beryllium ions was explained on the basis of the decomposition of potassium ferrocyanide and the subsequent formation of prussian blue. Conductometric titrations carried out at 30, 60, and 80° give evidence of the formation of an adsorption complex, $K_2BeFeCy_6 \cdot K_4FeCy_6$. (auth)

29147 STUDIES ON SOME LESS FAMILIAR FERROCYANOGEN COMPLEXES. PART V. INTERACTIONS OF Be(II) AND Cr(III) WITH POTASSIUM FERRO- AND FERRICYANIDES AT 80° AND THEIR COMPOSITION BY AMPEROMETRY. Wahid U. Malik (Muslim Univ., Aligarh, India). J. Indian Chem. Soc., 38: 297-302(May 1961). (In English)

The reactions of beryllium nitrate and chromic chloride with potassium ferrocyanide were studied at 80° employing the mercury pool as the reference electrode and potassium chlorate as the supporting electrolyte. Titrations between beryllium nitrate and potassium ferrocyanide were carried out at 80°. Evidence for the formation of the complex $K_2Be_3(II)(Fe(II)Cy_6)_2$ was obtained. Conductometric and potentiometric titrations between chromic chloride and potassium ferrocyanide do not give satisfactory results, but the amperometric titrations, carried out at 80°, give evidence for the formation of the complex $KCr(III)Fe(II)Cy_6$. Amperometric studies, carried out under similar conditions, give evidence for the formation of the complex $Cr(III)Fe(III)Cy_6$ by the interaction of chromic chloride and potassium ferricyanide at 80°. (auth)

29148 OXINE N-OXIDE AS AN ANALYTICAL REAGENT FOR THE COLORIMETRIC ESTIMATION OF CERIUM(IV) AND ITS COMPARISON WITH OXINE AS A CHELATING AGENT. A. N. Bhat and B. D. Jain (Univ. of Delhi). J. Indian Chem. Soc., 38: 327-30(May 1961). (In English)

Oxine N-oxide was investigated as an analytical reagent for the colorimetric estimation of cerium(IV), which produces a deep brownish red, water-soluble complex with an ethanolic solution of the reagent. The complex is quite stable, and the intensity of the color remains unchanged between pH 2.0 and 6.5. The complex obeys Lambert-Beer's law at 420 m μ up to a dilution of 9 ppm of cerium. Trivalent rare earths cerium, lanthanum, and yttrium do not interfere in the above estimation. (auth)

29149 A METHOD FOR REDUCING METHACRYLATE SUBLIMATION FROM THIN SECTIONS. L. E. Roth (Argonne National Lab., Ill.). J. Ultrastruct. Research, 5: 142-50(1961).

The loss of methacrylate by sublimation during electron bombardment causes minute artifacts in thin sections. A method is described of eliminating such loss by placing a methacrylate membrane over the sections before bombardment. The membrane thickness is such that it will be completely sublimed and lost during the time when the methacrylate in the section is being stabilized. Such a methacrylate membrane may also serve as the substrate; then the result is a section which is nearly substrate-free but has, nevertheless, been protected from sublimation. Optimum contrast, protection from sublimation, and high resolution can thus be achieved. (auth)

29150 A CONTRIBUTION TO THE DETERMINATION OF Sr^{90} IN SOILS. H. Reissig (Technische Hochschule, Dresden). Kernenergie, 4: 440-4(June 1961). (In German)

The possible poisoning of the human environment with radioactive materials released by nuclear weapons tests and by the development of reactor technology necessitates constant monitoring of the air, water, foods, soils, and plants for their contamination with radioisotopes. With consideration of the physical constants, the plant availability, and its metabolic-physiological behavior Sr^{90} has first place in the control of soil poisoning. An investigation was made on the simplification of the Sr^{90} separation process for soils (by the usual Ca-Sr separation) by using fuming nitric acid. The interference caused in the determination of Sr^{90} in soils by foreign activities was estimated, and their elimination was described. (tr-auth)

29151 RAPID DETERMINATION OF YTTERBIUM IN AQUEOUS SOLUTIONS AND IN THULIUM OXIDE BY NEUTRON ACTIVATION. Minoru Okada (Government Chemical Industrial Research Inst., Tokyo). Nature, 191: 1090(Sept. 9, 1961).

In analyses of aqueous samples, the coefficient of variation of a single analysis was 5%, the content of ytterbium was 0.064%. Since interfering activities were practically negligible and activities produced were on a level very suitable to the counter used, this value was felt to be the approximate lower limit of the coefficient of variation. In thulium oxide samples the resolution of the decay curve showed two components: 6 sec and 1.3 min. The latter was identified as dysprosium-165m. Results of analyses of thulium oxide samples as fine powder are tabulated. It was concluded from decay curves that when a thulium oxide powder contains 6 ppm dysprosium, the lower limit of ytterbium detection is about 0.01%. (P.C.H.)

29152 ROTATING-OSCILLATING-INDEXING MECHANISM FOR X-RAY ANALYSIS. R. R. Garlits and C. C. Bolt (Goodyear Atomic Corp., Portsmouth, Ohio). Norelco Repr., 8: No. 2, 37-8(Mar.-Apr. 1961). (GAT-T-862)

A specimen-scanning mechanism whereby rotating, oscillating, and indexing operations are accomplished

automatically by the use of a single rotating shaft is described. This mechanism may be used for the uniform scanning of powder samples when it is attached to a x-ray camera. This mechanism increases the precision of the camera and permits more effective and valuable use of the x-ray diffraction methods of analysis. (N.W.R.)

29153 POLAROMETRIC TITRATION OF THORIUM IN MONAZITE. Shao-Chun Tung and Er-Kang Wang (Inst. of Applied Chemistry, Academia Sinica, Peking). Sci. Sinica (Peking), 19: 403-10(1961). (In English)

After a thorough investigation of the properties of the elements in monazite and the characteristics of polarometric titration, decomposition and polarometric titration steps were combined. A dried sample is fused with potassium hydrogen bifluoride; by selecting a mixture of aluminum chloride, acetic acid, and sodium acetate as the supporting electrolyte, thorium can be rapidly and accurately determined by polarometric titration using ammonium molybdate as reagent. The optimum conditions are as follows: applied voltage -0.75 v, composition of supporting electrolyte: 1.5 N AlCl_3 , 7% CH_3COOH , and CH_3COONa (pH = 1.7). The precision of the determination lies within 2%. It takes three hours to carry through the determination. (auth)

29154 POLAROGRAPHIC DETERMINATION OF LEAD IN VERY PURE ALUMINUM. E. N. Vinogradova, L. N. Vasil'eva, and I. Iobst. Zavodskaya Lab., 27: 525-7(1961). (In Russian)

Lead contents of $10^{-6}\%$ were determined. Preliminary concentration is achieved by electrolytic separation on a static mercury drop. Admixtures of Zn, Cu, and Fe do not influence the determination. The effects of Cd were eliminated by intermetallic combination with Au. Ge was volatilized during the preparation, and Sn does not interfere at pH = 3. The analysis requires 1.5 hours. (tr-auth)

29155 DETERMINATION OF Li IN ORE ASSAYS BY NUCLEAR-PHYSICAL METHOD. E. I. Zaitsev and V. Yu. Zaleskii (All-Union Scientific-Research Inst. of Mineral Resources, USSR). Zavodskaya Lab., 27: 553-7(1961). (In Russian)

Determination of Li in ores by the $\text{Li}^6(n,\alpha)\text{H}^3$ reaction is described. With a source of 1.2×10^5 n/sec the detector sensitivity is 18.5 pulse/min per % Li_2O in a 16 pulse/min background. The relative error of the method is 50 to 60% with Li_2O contents from 0 to 0.5%. (tr-auth)

29156 PHOTOMETRIC DETERMINATION OF ZIRCONIUM. A. K. Babko and V. T. Vasilenko (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Zavodskaya Lab., 27: 640-4(1961). (In Russian)

Spectrophotometric analysis of 18 reagents forming colored zirconium complexes indicate that xylenol orange and methyl amyl blue are the most sensitive. (R.V.J.)

29157 DIFFERENTIAL SPECTROPHOTOMETRIC DETERMINATION OF TITANIUM IN ILMENITE CONCENTRATIONS. T. M. Mal'yutina and B. M. Dobkina (State Scientific Research and Design Inst. of Rare Metal Industry, [USSR]). Zavodskaya Lab., 27: 650-2(1961). (In Russian)

A differential spectrophotometric method was developed for determining Ti in ilmenite concentrations with admixtures of phosphoric acid for eliminating interference by iron. The accuracy is about ~0.5%. (R.V.J.)

29158 DIFFERENTIAL SPECTROPHOTOMETRIC DETERMINATION OF NEODYMIUM. T. M. Mal'yutina, B. M. Dobkina, and Yu. A. Chernikhov (State Scientific

Research and Project Inst. of Rare Metal Industry, [USSR]). Zavodskaya Lab., 27: 653-6(1961). (In Russian)

A differential spectrophotometric method was used for determining neodymium in oxide preparations and in magnesium-neodymium alloys. The order of accuracy is about ~1%. (R.V.J.)

29159 PHOTOCOLORIMETRIC DETERMINATION OF Nb in Ti AND Al ALLOYS WITH ARSENAZO REAGENT. E. I. Nikitina. Zavodskaya Lab., 27: 663-6(1961). (In Russian)

Conditions are found for the quantitative preparation of colored niobium complexes with arsenazo in presence of the sulfuric and tartaric acids. A method was developed for the photocolometric determination of niobium in titanium and aluminum and in their alloys. (R.V.J.)

29160 DETERMINATION OF Rb AND Cs IN A FORM OF RbBF_4 AND CsBF_4 . Z. T. Maksimychova, T. A. Maslentsova, and F. N. Suleimanova (Lenin Middle Asia State Univ.). Zavodskaya Lab., 27: 667-9(1961). (In Russian)

A gravimetric method is described for determining Rb and Cs in the form of fluoroborates with an accuracy of 1%. The presence of Ca, Mg, Fe, Al, Na, and Li up to 0.1 g does not interfere. (R.V.J.)

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Refer also to abstracts 28945, 28946, 28947, 28948, and 28954

29161 (AD-239616) RESEARCH ON THE RELATIONSHIPS BETWEEN THE MAGNETIC AND PHYSICAL PROPERTIES OF SULFIDES AND THEIR CRYSTAL STRUCTURE AND CHEMICAL COMPOSITION. Technical Status Report No. 6, January 15, 1960-April 14, 1960. Haakon Haraldsen (Oslo. Universitetet). Contract AF61 (052)-178. 10p.

A discussion is given of the results of magnetic property measurements of US_2 and US_3 from -183 to 420°C. The values are compared with two previous measurements carried out at room temperature. Vanadium sulfide specimens were prepared with the composition $\text{VS}_{0.990}$ to $\text{VS}_{1.200}$, and were studied by x-ray single-crystal and powder techniques. Powder photograph data are included for $\text{VS}_{1.075}$. (B.O.G.)

29162 (DP-614) CYANOGEN-FREE SPECTRA. J. Allen Wheat (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Aug. 1961. Contract AT(07-2)-1. 9p.

Spectra of volatile elements, essentially free of cyanogen bands, were produced when samples mixed with potassium chlorate were excited by a d-c arc. A specially designed electrode system was used to contain the sample. Although separation of volatile metal impurities from refractory elements was achieved, the results were insufficiently reproducible for the procedure to be developed into a general, quantitative analytical method. (auth)

29163 (NP-10707) ACTIVITY COEFFICIENTS OF LiNO_3 , HNO_3 , AND NH_4NO_3 IN DOWEX-1 ANION-EXCHANGE RESIN. J. Danon (Rio de Janeiro. Centro Brasileiro de Pesquisas Fisicas). 1961. 11p. (Notas de Física Vol. VII, No. 9).

The nitrate solutions were passed over the resin in a

sintered glass funnel until partition equilibrium was attained. The funnel was centrifuged to constant weight, and the resin washed to remove the imbibed electrolyte. Determinations were made for: HNO_3 , by titration with standard NaOH; LiNO_3 , by flame photometry in an Electroselectium photometer; and NH_4NO_3 , by displacement with concentrated NaOH in a distillation apparatus and collecting the products over H_2SO_4 of known molarity. The results obtained are summarized and show a similarity with other systems. (B.O.G.)

29164 (TID-13497) ELECTROCHEMICAL REDUCTION OF PURINE, ADENINE AND RELATED COMPOUNDS; POLAROGRAPHY AND MACROSCALE ELECTROLYSIS. Report No. 62. David L. Smith and Philip J. Elving (Michigan. Univ., Ann Arbor). Aug. 1, 1961. Contract AT(11-1)-70. 41p.

The electrochemical reduction of purine and certain derivatives was examined polarographically, coulometrically, and by macroscale reduction over the normal pH range. The reduction products were investigated spectrophotometrically and chemically as well as polarographically. Purine is reduced in two $2e^-$ stages: the first stage involved reduction of the 1,6 double bond to 1,6-dihydropurine; the second stage involves further reduction to 1,2,3,6-tetrahydropurine which then hydrolyzes to a 4-aminoimidazole. The product of the first purine $2e^-$ reduction is slowly oxidized in the presence of oxygen to regenerate purine. Adenine (6-aminopurine) undergoes a single $6e^-$ reduction, which involves a $2e^-$ hydrogenation of the 1,6 double bond, followed by the $2e^-$ reduction of the 2,3 double bond, deamination at the 6-position, further $2e^-$ reduction of the regenerated 1,6 double bond, and hydrolytic cleavage at the 2,3 position to give the same product as in the over-all $4e^-$ purine reduction. Under polarographic conditions the deamination of adenine is negligible, resulting in a $4e^-$ wave. Hypoxanthine (6-hydroxypurine) apparently only undergoes a $2e^-$ reduction to 2,3-dihydrohypoxanthine, which then hydrolyzes. 2-Hydroxypurine is postulated to be reduced at about the same potential as purine itself. Adenine and the completely reduced forms of it and of purine lower the overpotential of hydrogen ion reduction. (auth)

29165 (UCRL-9821) KINETICS OF THE OXIDATION OF MAGNESIUM FLUORIDE (thesis). Donald R. Messier (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 15, 1961. Contract W-7405-eng-48. 32p.

The kinetics of the reaction between MgF_2 and water vapor were studied in the temperature range from 950 to 1100°C. Determinations on powdered, sintered polycrystalline, and single-crystal specimens yielded different activation energies. The differences were attributed to differences in microstructure among the several specimen types. Reaction rates were determined by measuring weight loss with a silica helix and cathetometer arrangement. The reaction was carried out in a flowing atmosphere of argon which possessed a known water-vapor partial pressure. With all sample types, the reaction was interface-controlled. After the attainment of steady-state conditions, a 2/3-order rate law was followed. Activation energies of 25 ± 6 , and 42.3 ± 5 kcal per mole were obtained for the powdered, sintered polycrystalline, and single-crystal specimens, respectively. The single-crystal value agreed with the heat of reaction of 43.8 kcal per mole, indicating that the rate-controlling step was the chemical reaction itself. The low value for the powdered specimens was a result of area changes caused by sintering. The structure of the product layer on the presintered poly-

crystalline specimens was such that it provided greater permeability to gas flow than the single-crystal product. Consequently, a greater reaction-rate temperature was required. Efficient and higher activation energy resulted. (auth)

29166 (AE-tr-1) UNDERSÖKNINGAR PÅ OMRÅDET FÖR KRYSTALLISERADE BLANDKRISTALLER MED HJÄLP AV RADIOAKTIVA INDIKATORER. (Investigations of the Anomalies in Various Crystals with the Aid of Radioactive Indicators).

M. Ioffe. Translated into Swedish by J. Mednis from *Radiochimica Acta*, 1: No. 1, 22-5 (1959). 7p.

The formation of abnormal mixed crystals from the solutions $\text{NH}_4\text{Cl}-\text{FeCl}_3-\text{CrCl}_3-\text{H}_2\text{O}$ and $\text{NH}_4\text{Cl}-\text{MnCl}_2-\text{FeCl}_3-\text{H}_2\text{O}$ was studied with the help of radioactive indicators. The concentration of Cr in the solid phase was determined as a function of the concentration of Fe and Cr in the initial solution. The distribution coefficient of Cr was studied as a function of the iron. The concentration of Mn and Cu in the crystals was determined as a function of the concentration in the initial solution. An hypothesis is proposed to explain the resulting crystals is given and discussed. (S.R.)

29167 (CEA-tr-R-1374) EQUATION D'ETAT DE L'EAU LOURDE D_2O D'APRES LES DONNEES EXPERIMENTALES DE $p-v-T$. (Equation of State of D_2O from $p-v-T$ Experimental Data). A. M. Mamedov. Translated into French from *Teploenergetika*, 7: 71-4 (1960). 12p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 15, abstract no. 2011.

29168 (NP-tr-744) STRUCTURAL STUDY OF THE DEHYDRATION OF MAGNESIUM HYDROXIDE. Julio Carrido. Translated by M. L. Awcock for U.K.A.E.A., Atomic Energy Research Establishment, Harwell, Berks, Eng. from *Ion*, 11: 206-13; 220; 453-64 (1951). 59p. (Includes original, 15p.).

The x-ray diffraction study of the dehydration of $\text{Mg}(\text{OH})_2$ showed that the MgO crystallites maintain a certain crystallographic orientation with respect to the structure of the hydroxide. Notations are included illustrating the connections between the two orientations of the MgO crystallites and the hydroxide lattice. The study was performed by analyzing the dehydration products for increasing periods of time, thus enabling the construction of a curve expressing the formation of MgO crystallites as a function of time. The phenomena was found to differ when the dehydration takes place at low temperatures rather than at high temperatures. The existence of these differences at high and low temperatures seems to confirm certain thermodynamic conclusions reached in previous investigations. (B.O.G.)

29169 LIQUID-VAPOR EQUILIBRIA IN THE HYDROGEN-NITROGEN AND DEUTERIUM-NITROGEN SYSTEMS. Arturo Maimoni (Univ. of California, Livermore). *A.I.Ch.E. Journal*, 7: 371-5 (Sept. 1961). (UCRL-5719)

A recirculation type apparatus with a novel liquid-sampling system was used to obtain liquid-vapor equilibrium data for the hydrogen-nitrogen and deuterium-nitrogen systems at 90 and 95°K and pressures up to 1000 lb/sq in. abs. The data obtained show an average scatter in liquid compositions of the order of 0.01%, thus proving the feasibility of the new liquid-sampling system. The vapor samples are shown by thermodynamic analysis to scatter less than 0.1%. Deuterium is slightly more soluble in liquid nitrogen than hydrogen; the relative volatility is 1.198 at 90°K and about 1.177 at 95°K. The relative volatility is practically independent of pressure; thus at 90°K the relative volatility decreases from

1.198 at 100 lb/sq in. abs to 1.196 at 1000 lb/sq in. abs, but this range of values is well within the experimental error. (auth)

29170 SPACE GROUPS OF SOME COORDINATION COMPOUNDS OF COBALT. M. Mathews, K. S. Viswanathan, and N. R. Kunchur (Atomic Energy Establishment, Trombay, India). *Acta Cryst.*, 14: 1007 (Sept. 10, 1961).

The unit cell dimensions and space groups of some coordination compounds of cobalt(III) are presented. The cell dimensions are measured from rotation photographs and the space-group absences are determined from the zero- and first-layer Weissenberg photographs taken about the principal axes using Fe K-alpha radiation. The compounds are sodium salt of cobalt(III) ethylenediaminetetraacetate tetrahydrate, cobalt(III) tris-glycinate dihydrate, cobalt(III) bis-dimethylglyoximino diamine thiocyanate, and cobalt(III) bis-dimethylglyoximino diamine perchlorate. (N.W.R.)

29171 THE MONOURANATES OF COBALT AND MANGANESE. Cesare Brisì. *Atti accad. Torino. I. Classe sci. fis., mat. e nat.*, 95: 534-9 (1960-61) (Pub. 1961). (In Italian)

The uranates CoUO_4 and MnUO_4 were prepared by high temperature reactions between U_3O_8 and the oxides of Mn and Co. Both the compounds crystallize in the rhombic system, spatial group D_{2h}^{28} , with the following lattice constants: $a_0 = 6.49$, $b_0 = 6.52$, and $c_0 = 6.96$ Å for CoUO_4 and $a_0 = 6.66$, $b_0 = 6.76$, and $c_0 = 6.99$ Å for MnUO_4 . The two uranates lose oxygen when they are heated in air to temperatures of the order of 1200°C. (tr-auth)

29172 A STUDY OF RED PHOSPHORUS WITH THE MASS SPECTROMETER. Jean-Denis Carette and Larkin Kerwin (Université Laval, Quebec). *Can. J. Phys.*, 39: 1300-19 (Sept. 1961). (In French)

A source is described for solid samples which may be quickly heated to a desired temperature of from 100 to 800°C and maintained to $\pm 3^\circ\text{C}$. An analysis of lithium isotopes gives a ratio of 12.42 for the 7/6 isotopes and establishes that the source does not mass-discriminate. The results are given of an analysis of red phosphorus, including the relative abundances of P^+ , P_2^+ , P_3^+ , P_4^+ , and P_5^+ as a function of temperature and bombarding electron energy, the appearance potential curves, suggested formation reactions and energy values, the identification of doubly charged ions, negative ions, and Aston bands, and values for heats of vaporization. The results indicate that the various molecular species sublime directly from the solid. (auth)

29173 THE ELECTRONIC SPECIFIC HEAT OF LITHIUM-MAGNESIUM ALLOYS. Douglas L. Martin (National Research Council, Ottawa). *Can. J. Phys.*, 39: 1388-90 (Sept. 1961). (NRC-6450)

The main feature of the results of specific heat measurements on lithium-magnesium alloys (alloys contain 1 and 10 atomic % magnesium) is the smooth variation of both the electronic specific heat coefficient and the Debye temperature between the values for the pure metals. As an explanation of the similarity of the results, it is assumed that the lithium and alloys are transformed to the hexagonal phase. The variation of the electronic specific heat coefficient on going from pure lithium to pure magnesium is due to the variation in the average number of electrons per atom. The variation may also be attributed to an alteration in the density of states at the Fermi level and to alterations in the effects of the electron-phonon and electron-electron interactions on the electronic specific

heat. The observed electronic specific heat decreases with increase in electron density while the Sommerfeld free electron value increases with increase of electron density. The specific heats are 389, 386.7, 366.3, and 292.7 $\mu\text{cal}/^\circ\text{K}^2$ g-atom, respectively, for lithium, lithium-1 atomic % magnesium, lithium-10 atomic % magnesium, and magnesium. (N.W.R.)

29174 ALKALINE EARTH PHOSPHATES. Richard W. Mooney and Michael A. Aia (Sylvania Electric Products Inc., Towanda, Penna.). Chem. Revs., 61: 433-62 (Oct. 1961).

A review is given on the comparison of the phase relationships, chemistry, structure, and properties of the alkaline earth phosphates, with emphasis on the phosphates of strontium and barium. In general, the discussion of phase relationships and structures considers only the systems $\text{MO}-\text{P}_2\text{O}_5-\text{H}_2\text{O}$ and $\text{MO}-\text{P}_2\text{O}_5$, where M is calcium, strontium, or barium. However, important thermodynamic and crystal structure work on the calcium phosphates are included in order to permit comparisons with the strontium and barium systems and to make the review complete through 1959. 235 references are given to books, reports, and U. S. and foreign journals published from 1866 to 1961. (P.C.H.)

29175 THE SPECIFIC HEAT CAPACITY C_v OF WATER AND WATER VAPOR AT HIGH TEMPERATURES AND PRESSURES. Kh. I. Amirkhanov and A. M. Kerimov (Dagestan Branch, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 139: 398-401 (July 11, 1961). (In Russian)

Data on the heat capacity C_v are given as a function of temperature at constant volumes of $V_1 = 1.012$, $V_2 = 1.043$, $V_3 = 1.091$ and $V_4 = 1.156$ cm^3/g . The isochores of the specific volumes V_1 and V_2 include data on the specific heat capacity C_v over a range of pressures of 1 to 800 atm. for the liquid. On passing from a two-phase region to a single phase region, the heat capacity C_v decreases with increasing temperature and pressure. The rate of decrease of the heat capacity with temperature is larger for V_1 than it is for V_2 . Isochores on the decrease of heat capacity C_v with temperature are also presented for $V_5 = 1.251$, $V_6 = 1.404$, $V_7 = 1.741$, $V_8 = 2.7$ and $V_9 = 3.23$ cm^3/g , and the critical temperature $T_c = 374.34^\circ\text{C}$. On increasing the specific volume from V_1 to V_7 , for which the transition temperatures are $T_1 = 50^\circ\text{C}$ and $T_7 = 350^\circ\text{C}$, the heat capacity decreases from 0.975 to 0.752 cal/g/deg. Then, the heat capacity rises sharply and reaches a maximum of 1.69 cal/g/deg. at the critical point. (TTT)

29176 THE HOMOLOGOUS SERIES OF URANIUM OXIDES $\text{U}_n\text{O}_{2n+2}$. E. S. Makarov (Bernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 139: 612-15 (July 21, 1961). (In Russian)

The theory of homologous series formation of the transition metal oxides is applicable also to the U-O system. UO_4 ($n = 1$) exists only as the uranate ion or as the hydrate $\text{UO}_4 \cdot 2\text{H}_2\text{O}$. For $n = 2$, UO_6 is known in at least 5 polymorphic modifications. The hexagonal structure of the α -form and the cubic structure of the δ -modification was confirmed using neutron diffraction. For $n = 3$, U_3O_8 exists in an orthorhombic low-temperature form and in a triclinic modification beyond 400°C . The compound U_2O_5 ($n = 4$) represents the low-O boundary of the homogeneous region within $\text{UO}_{2.5-3}$. The compound corresponding to $n = 5$, U_5O_{12} was observed among the low-temperature oxidation products of UO_2 as a tetragonal $\text{UO}_{2.40}$, together with U_3O_7 ($n = 6$), corresponding to $\text{UO}_{2.33}$, although its structure is not def-

initely established yet. U_7O_{16} is located in the $\text{UO}_{2.28-2.31}$ region. For $n = 8$, the compound U_8O_{18} was reported by several authors as $\text{UO}_{2.25}$ representing the upper limit of the transition region saturated with O. It is expected that the higher members of the series, U_9O_{20} , $\text{U}_{10}\text{O}_{22}$, $\text{U}_{11}\text{O}_{24}$ will be reported soon. (TTT)

29177 NEW METHOD OF PREPARATION OF ZIRCONIUM TETRAACYLOXYL COMPOUNDS. E. M. Brainina, R. Kh. Freidlina, and A. N. Nesmeyanov (Inst. of Elemento-Organic Compounds, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 4, 608-12 (Apr. 1961). (In Russian)

Tetraacyloxyl compounds of $[\text{X}(\text{CH}_2)_n \text{COO}]_4 \text{Zr}$ (where $n = 4, 5, 6, 10, 11, 15$, and 17 and $\text{X} = \text{H}$ and Cl) were derived by exchange reactions of zirconium tetraacetylacetonate with carboxylic acid. Diacyloxyl compounds ($n - \text{C}_{17}\text{H}_{35}\text{COO}$) $_2 \text{Co}$ and ($\text{C}_n\text{H}_{2n+1}\text{COO}$) $_2 \text{Mn}$ (where $n = 15$ or 17) were derived by reactions of cobalt and manganese triacetylacetonates with stearic and palmitic acids. (R.V.J.)

29178 ON THE PRODUCTION OF URANIUM CARBIDES. III. ON THE SYNTHESIS OF URANIUM DICARBIDE. Yoshihiko Takada, Shosuke Imoto, and Tadao Sano (Osaka Univ.). J. At. Energy Soc. Japan, 3: 513-18 (July 1961). (In Japanese)

Uranium dicarbide was produced by the reaction between uranium powder and propane gas at temperatures above 800°C . The yield of the dicarbide, which was determined by powder x-ray diffraction, depends upon the reaction temperature and period. When the amount of propane selected to react with uranium was about twice as much as the stoichiometric amount, the pressure change during the reaction can be used to estimate the yield of the dicarbide. The change of pressure accompanying the reaction was divided into two stages. At the first stage, the change in pressure was rapid; at the second slow. At the first stage, UC and UC_2 were synthesized by the reaction of uranium with free radicals from propane; at the second stage, UC slowly reacted with secondary products of propane, synthesizing the dicarbide. When a reaction was carried out between uranium and propane at 800°C or above, the dicarbide was produced in large amounts. (auth)

29179 ANHARMONIC POTENTIAL CONSTANTS AND THEIR DEPENDENCE UPON BOND LENGTH. Dudley R. Herschbach (Univ. of California, Berkeley) and Victor W. Laurie. J. Chem. Phys., 35: 458-63 (Aug. 1961). (UCRL-9537)

Empirical study of cubic and quartic vibrational force constants for diatomic molecules shows them to be approximately exponential functions of internuclear distance. A family of curves is obtained, determined by the location of the bonded atoms in rows of the periodic table. Displacements between successive curves correspond closely to those in Badger's rule for quadratic force constants (for which the parameters are redetermined to accord with all data now available). Constants for excited electronic and ionic states appear on practically the same curves as those for the ground states. Predictions based on the diatomic correlations agree with the available cubic constants for bond stretching in polyatomic molecules, regardless of the type of bonding involved. Implications of these regularities are discussed. (auth)

29180 ENERGY VALUE OF THE OCTAHEDRAL-TETRAHEDRAL COORDINATION CHANGE. Leonard I. Katzin (Argonne National Lab., Ill.). J. Chem. Phys., 35: 467-72 (Aug. 1961).

The equilibrium $^{\text{oct}}(\text{CoCl}_2\text{Py}_4) = ^{\text{tet}}(\text{CoCl}_2\text{Py}_2) + 2 \text{Py}$ for cobaltous chloride solutions in pyridine is followed over a

temperature range, yielding $\Delta H = +13.4$ kcal/mole. At 8°C the equilibrium constant is estimated as $(\text{CoPy}_2\text{Cl}_2)/(\text{Py})^2/(\text{CoCl}_2\text{Py}_4) = 0.04$, and the ΔS for the reaction is about 36.7 eu. It is pointed out that the average bond strength in the tetrahedral species is about 17 kcal greater than for the same groups in the octahedral configuration, and that the strength of binding and the dissociation energy for the two ligands released according to the equation above are significant factors in determining the equilibrium reaction. Detailed arguments are given against the view that the relative stability of octahedrally and tetrahedrally coordinated complexes, such as the pair discussed, reflect principally the difference in "ligand-field stabilization" of the nonbonding d electrons between octahedral and tetrahedral fields. (auth)

29181 MOLECULAR DETACHMENT PROCESSES IN THE VACUUM uv PHOTOLYSIS OF GASEOUS HYDROCARBONS. I. ETHYLENE. II. BUTANE. Myran C. Sauer, Jr. and Leon M. Dorfman (Argonne National Lab., Ill.). J. Chem. Phys., 35: 502(Aug. 1961).

The photolysis of ethylene and of butane was studied at room temperature with light of 1470 Å. The results of isotopic studies, along with a detailed examination of the products of reaction, establish conclusively that molecular detachment processes are of major importance in the primary decomposition of the photoexcited states formed. In the photolysis of ethylene at 1470 Å the primary processes are $\text{C}_2\text{H}_4^* = \text{C}_2\text{H}_2 + \text{H}_2$, ϕ_1 ; $\text{C}_2\text{H}_4^{**} = \text{C}_2\text{H}_2 + 2\text{H}$, ϕ_2 ; with $\phi_1 \cong \phi_2$. Rupture of only a single carbon-hydrogen bond is not an important primary process. The foregoing reactions, along with the subsequent interactions of ethyl radicals, formed by hydrogen atom addition to ethylene, furnish a unique description of almost all the photochemistry observed under the conditions of the experiments. In the photolysis of butane at 1470 Å, molecular detachment of hydrogen: $\text{C}_4\text{H}_{10}^* = \text{C}_4\text{H}_8 + \text{H}_2$ is a major primary process. (auth)

29182 PARAMETERIZATION OF ORTHOGONALITY AND NORMALIZATION CONDITIONS FOR THE NbF_7^{2-} STRUCTURE. Russell L. Wilson and George H. Duffey (South Dakota State Coll., Brookings). J. Chem. Phys., 35: 568-70(Aug. 1961).

General spd hybrid orbitals of C_{2v} symmetry were set up for the distorted trigonal prism NbF_7^{2-} structure. The orthogonality and normalization conditions were introduced and expressed in parametric form. On varying the parameters, the authors found the greatest Pauling strength, averaging 2.987, when the composition was $s^{0.89}p^{2.49}d^{3.62}$. (auth)

29183 URANIUM MONOSULFIDE. I. VAPORIZATION, THERMODYNAMICS, AND PHASE BEHAVIOR. E. David Cater (Univ. of Kansas, Lawrence and Argonne National Lab., Ill.), Paul W. Gilles, and R. J. Thorn. J. Chem. Phys., 35: 608-18(Aug. 1961).

The rate of evaporation of uranium monosulfide was measured over the 900-deg temperature range 1840 to 2730°K and a pressure range 10^{-3} to 10^{-8} atm, with an estimated accuracy of $\pm 4\%$, by collection of vapor effusing from tungsten effusion cells containing the solid. The congruently evaporating composition was shown to be $S/U = 1.00$. The effusion rate is expressed in terms of an "effective" vapor pressure P_E calculated as though the entire vapor consisted of gaseous US molecules. An empirical equation derived by the method of least squares from the data is $\log P_E(\text{atm}) = -1.7382 + 3.127 \times 10^4/T - 1.3181 \times 10^8/T^2 + 0.093776 \times 10^{12}/T^3$. Mass spectrometric measurements [E. D. Cater, E. G. Rauh, and R. J. Thorn, J. Chem. Phys., 35: 619(1961)] show that the vaporiza-

tion actually occurs both to gaseous US and to gaseous $U + S$. The present data are treated to yield the heats of sublimation at 2300°K to gaseous molecules, 150.3 ± 2.1 , and to gaseous elements, 271.2 ± 4.0 kcal/mole, where the quoted uncertainties are estimated errors. The corresponding entropies of sublimation are: to molecules, 38.4 ± 0.6 , and to atoms, 65.5 ± 1.6 cal/deg-mole. The lattice parameter of uranium monosulfide is 5.4903 ± 0.0002 Å. The melting point is $2735 \pm 30 - 5^\circ\text{K}$. The monosulfide solid phase appears to encompass a small composition range. Values derived from the experimental data and the literature for absolute entropies at 2300°K are 45 ± 2 eu for solid, and 83 ± 3 eu for gaseous US, where estimated errors are given. The heat of formation of solid US at 298°K from the gaseous atoms is estimated to be -273 ± 5 kcal/mole and from the solid elements, -90 ± 5 . The free energies of formation of solid and gaseous monosulfide between 2100 and 2400°K are expressed by the equations $\Delta F_f^\circ(\text{US}, s) = 64.0 T - 268000$ cal/mole; $\Delta F_f^\circ(\text{US}, g) = 38.8 T - 152000$ cal/mole. A semitheoretical treatment gives nonlinear equations for the temperature dependences of the free energies and entropies of vaporization. (auth)

29184 URANIUM MONOSULFIDE. II. MASS SPECTROMETRIC STUDY OF ITS VAPORIZATION. E. David Cater (Univ. of Kansas, Lawrence and Argonne National Lab., Ill.), E. G. Rauh, and R. J. Thorn. J. Chem. Phys., 35: 619-24(Aug. 1961).

A study of the vapor effusing from a tungsten effusion cell containing uranium monosulfide was performed with the aid of a time-of-flight mass spectrometer. Between 1700° and 2150°C uranium monosulfide vaporizes predominantly according to the reactions $\text{US}(s) = \text{US}(g)$, and $\text{US}(s) = \text{U}(g) + \text{S}(g)$, and to a detectable extent at 2100°C and above by the reaction $2 \text{US}(s) = \text{US}_2(g) + \text{U}(g)$. Least squares treatment of the ion current ratio $I_{\text{US}^+}/I_{\text{U}^+}$ as a function of temperature between 1885° and 2130°C yields the relationship $\Delta H_T^\circ(\text{I}) - [\Delta H_T^\circ(\text{II})/2] = 14.6 \pm 2.4$ kcal/mole, where the error is estimated. In the presence of very small amounts of oxygen in the solid monosulfide the vapor species UO and UOS are found. A faint peak in the spectrum at mass 264 is suspected to have been due to ThS^+ . (auth)

29185 DEIONIZATION CROSS SECTION FOR OXYGEN. R. G. Breene, Jr. (General Electric Co., Philadelphia). J. Chem. Phys., 35: 625-9(Aug. 1961).

Atomic- and free-electron wave functions are applied to the calculation of the deionization cross section for O II . The s- and d-wave numerical solutions to the free-electron wave equation are fitted to Coulomb functions for normalization. This result is used to determine the cross section for the transitions s wave to 2p orbital and d wave to 2p orbital. An approximate calculation for the transition to the 3p orbital with the resulting indication that the hydrogen result may reasonably be used was carried out. For the contributions from transitions to 3d and higher orbitals the hydrogen cross sections were adopted. The final result is $198 \times 10^{-21} \text{ cm}^2$ leading to a rate constant for radiative deionization of $218 \times 10^{-14} \text{ cm}^3/\text{sec}$. (auth)

29186 HEAT CAPACITIES OF DyCo_5 IN RELATIONSHIP TO ITS MAGNETIC ANOMALY, THIRD LAW ENTROPIES, AND RELATED THERMOCHEMICAL DATA. William G. Saba and W. E. Wallace (Univ. of Pittsburgh). J. Chem. Phys., 35: 689-92(Aug. 1961).

Heat capacities of DyCo_5 are reported for the temperature range at 12 to 470°K. Evaluation of the third law entropies of the compound gives $[\ln \text{ cal deg}^{-1} (\text{g formula weight})^{-1}]$ 55.61 ± 0.05 and 72.05 ± 0.07 at 298.16 and

450°K, respectively. Excess heat capacity is observed at 275 to 400°K, seemingly due to the previously observed magnetic anomaly at 360°K. Analysis of the data suggests that there is an appreciable magnetic contribution to the heat capacity throughout the temperature range covered. The profile of the thermal anomaly at about 350°K is unusual suggesting that the alteration of magnetic structure which produces it is also unusual. (auth)

29187 ABSORPTION SPECTRA OF VANADIUM, NIOBIUM, AND TANTALUM PENTOXIDES. D. C. Conlon and W. P. Doyle (University Coll., Dublin). *J. Chem. Phys.*, 35: 752-3(Aug. 1961).

Optical sorption in thin films of vanadium, niobium, and tantalum pentoxides was measured at 200 to 1000 μ . Data are presented graphically. (L.N.N.)

29188 PARAMAGNETIC RESONANCE OF SOME COPPER COMPLEX COMPOUNDS. J. A. McMillan and B. Smaller (Argonne National Lab., Ill.). *J. Chem. Phys.*, 35: 762-4(Aug. 1961).

Electron paramagnetic resonance spectra of Cu α -picolinate, Cu dipyriddy₂ SO₄, Cu pyridine₄ SO₄, and Cu pyridine₄ S₂O₈ were observed. A dual modulation spectrometer operating at 9 k Mc was used at 77°K. Derived spectra and sorption curves are plotted and results are summarized in tabular form. (L.N.N.)

29189 HYDRIDO-COMPLEXES OF RUTHENIUM(II) AND OSMIUM(II). J. Chatt and R. G. Hayter (Imperial Chemical Industries, Ltd., Welwyn, Herts, Eng.). *J. Chem. Soc.*, 2605-11(July 1961).

A series of hydrido-complexes of the types trans-[MHX(chelate)₂] was prepared and are shown to have considerable thermal stability, especially when the diphosphine contains aromatic groups. The unique hydrogen atom shows a large chemical shift in the nuclear magnetic resonance spectrum and causes an absorption band (ν_{M-H}) in the infrared spectrum in the region 1600–2050 cm^{-1} . The dipole moments ($X \neq H$) are of the order 5 D. The effect of X on ν_{M-H} is discussed and a possible correlation with kinetic data suggested. (auth)

29190 THE DISSOLUTION OF BERYLLIUM IN AQUEOUS SOLUTIONS OF MINERAL ACIDS AND AMMONIUM FLUORIDE. C. J. Hardy and D. Scargill (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *J. Chem. Soc.*, 2658-63(July 1961).

The rates of dissolution of beryllium metal in aqueous solutions of nitric, sulfuric, hydrochloric, and hydrofluoric acid, and of ammonium fluoride, were measured, and the relative rates for equimolar concentrations of the acids under similar conditions were found to be $\text{HF} > \text{H}_2\text{SO}_4 \approx \text{HCl} > \text{HNO}_3$. The rate varies with the source and method of fabrication of the metal. Dissolution of beryllium in nitric acid was examined in detail as a function of acid concentration, temperature, surface properties of the metal, and the presence of hydrofluoric acid. (auth)

29191 THE REACTION OF URANIUM WITH SOLUTIONS OF ALKYLAMMONIUM NITRATES IN DINITROGEN TETROXIDE; SOME PROPERTIES OF ALKYLAMMONIUM URANYL NITRATES. C. C. Addison and N. Hodge (The University, Nottingham, Eng.). *J. Chem. Soc.*, 2987-94(July 1961).

The reaction of metallic uranium, or uranium oxides, with solutions of alkylammonium nitrates in liquid dinitrogen tetroxide is a satisfactory and rapid method for the preparation of alkylammonium uranyl nitrates $\text{UO}_2(\text{NO}_3)_2$, MNO_3 or $\text{UO}_2(\text{NO}_3)_2 \cdot 2\text{MNO}_3$ (where M is EtNH_3 , Et_2NH_2 , Et_3NH , or Et_4N). With ethylammonium nitrate, both com-

pounds can be prepared. With di- and tri-ethylammonium nitrate only the 1:1 compound is isolated; a mixture of the two compounds is obtained with tetraethylammonium nitrate. In the reactions with metallic uranium, uranium(IV) compounds are formed as intermediates and have a greater stability in these solutions than in dinitrogen tetroxide alone. Solutions of the 1:1 compounds in nitromethane were studied by the methods of electrolysis, conductometric titration, light absorption, molecular weight, and ultraviolet spectra, and shown to contain the $[\text{UO}_2(\text{NO}_3)_3]^-$ ion. Solutions of the 1:2 compounds also contain this anion, and no evidence was found for the existence of the ion $[\text{UO}_2(\text{NO}_3)_4]^{2-}$ in non-aqueous solvents. Some rates of reaction of uranium with alkylammonium nitrate solutions are recorded. (auth)

29192 STUDIES IN ZIRCONIUM OXIDE SOLS. PART I. ELECTRICAL CONDUCTANCE OF ZIRCONIUM OXIDE SOLS. A. M. Trivedi, I. M. Bhatt, and M. J. Patani (M. G. Science Inst., Ahmedabad, India). *J. Indian Chem. Soc.*, 38: 288-90(May 1961). (In English)

Concentrated zirconium oxide sols of fairly high purity were prepared by hydrolyzing zirconium nitrate, followed by continued hot dialysis. When diluted sols are allowed to age, the specific conductance increases due to desorption of the adsorbed electrolyte. In the case of the concentrated sol, aging results in the decrease of specific conductance due to aggregation of the particles. Equivalent conductance of the micelles on dilution first decreases and then increases on further dilution, showing the behavior of a typical colloidal electrolyte. (auth)

29193 STUDIES IN ZIRCONIUM SOLS. PART II. HYDRATION OF MICELLES IN ZIRCONIUM OXIDE SOLS. A. M. Trivedi, I. M. Bhatt, and M. J. Patani (M. G. Science Inst., Ahmedabad, India). *J. Indian Chem. Soc.*, 38: 291-2(May 1961). (In English)

Hydration of the micelles in the case of zirconium oxide sols was studied by considering the distribution of an electrolyte (NH_4Cl) as a reference substance across a semi-permeable membrane. Neglecting the membrane equilibrium effect, the value of hydration comes out to be 62 moles of water per mole of zirconium oxide. This value is in agreement with that obtained by the viscosity method. The charge on the micelles was found to be 0.4 meq of NO_3^- per g of zirconium oxide. (auth)

29194 INFRARED TRANSMITTANCE OF CRYSTALLINE YTTRIUM OXIDE AND RELATED COMPOUNDS. K. A. Wickersheim and R. A. Lefever (Hughes Research Labs., Malibu, Calif.). *J. Opt. Soc. Am.*, 51: 1148-8(Oct. 1961).

Preliminary data are given on the optical and infrared properties of yttrium oxide and several related compounds (Al_2O_3 , MgO , $(\text{Y}_{0.95}\text{La}_{0.05})_2\text{O}_3$, and Yb_2O_3). The optical properties of yttrium oxide in the visible and ultraviolet are found to be strongly sensitive to the impurities in the initial powders, the properties in the infrared transmittance are much less so. The point at which the transmittance drops to one-half the reflection-loss-only value can be seen to fall between 8.0 and 8.1 μ for MgO , Y_2O_3 , and the mixed yttrium-lanthanum oxide and at about 7.2 μ for ytterbium oxide. The bands show OH vibrational absorption near 3 μ . (N.W.R.)

29195 INFRARED TRANSMITTANCE OF STRONTIUM TITANATE FROM ROOM TEMPERATURE TO -180°C . Calvin D. Salzberg (Eastman Kodak Co., Rochester, N. Y.). *J. Opt. Soc. Am.*, 51: 1149-50(Oct. 1961).

Successive transmittance measurements were performed on 1, 3, 5, and 10 mm thick samples of strontium titanate

at -187 to 26°C . Over the entire range of temperatures there was no significant change in transmittance from 1 micron to the first absorption trough at 4.65 microns. Beyond this absorption band there was about a 5% increase in transmittance and about a 0.1 micron shift in the main absorption edge toward longer wavelengths. The results indicate that strontium titanate suffers no loss of transmittance with cooling. A schematic drawing is given of the vacuum cell used for the low temperature transmittance measurements, and the data are supplemented with graphs. (N.W.R.)

29196 PHASE BEHAVIOR AND THERMAL PROPERTIES OF THE SYSTEM $\text{NH}_4\text{F}-\text{HF}$. Robert D. Euler and Edgar F. Westrum, Jr. (Univ. of Michigan, Ann Arbor). *J. Phys. Chem.*, 65: 1291-6 (Aug. 1961).

The system $\text{NH}_4\text{F}-\text{HF}$ was studied by thermal analysis between the limits NH_4HF_2 and HF . No indication of the composition $\text{NH}_4\text{H}_2\text{F}_3$ was found. Low temperature heat capacity measurements on four compositions approximating $\text{NH}_4\text{H}_3\text{F}_4$ confirmed and extended the thermal analysis and revealed the existence of a solid solution at this composition. Several thermal anomalies were found between 180°K and the melting point. The decomposition pressure of $\text{NH}_4\text{H}_3\text{F}_4$ was also determined. (auth)

29197 CORRECTION OF THE POTASSIUM VAPOR PRESSURE EQUATION BY USE OF THE SECOND VIRIAL COEFFICIENT. R. J. Thorn and G. H. Winslow (Argonne National Lab., Ill.). *J. Phys. Chem.*, 65: 1297-1302 (Aug. 1961).

The available thermodynamic properties of saturated potassium vapor were used to predict the dissociation energy of the dimer on the basis of a perfect gas treatment including the diatomic molecules, and on the basis of predictions from an imperfect gas treatment in which it was assumed that the inclusion of the second virial coefficient in the equation of state was adequate. A statistically certain experimental distinction between the two treatments cannot be made because of a large discrepancy in the high temperature vapor pressure measurements, though sufficient precision can be obtained to make the distinction. The evidence supports the imperfect gas treatment and the spectroscopic value of the dissociation energy. The most consistent set of thermodynamic properties is: $\log p_1(\text{ideal}) = -4802.27/T - 1.97108 \log T + 4.9800 \times 10^{-4} T - 1.0659 \times 10^{-7} T^2 + 10.14506$. $\log p_2(\text{ideal}) = -6.98 \times 10^3/T - 4.44216 \log T + 1.04976 \times 10^{-3} T - 2.1317 \times 10^{-7} T^2 - 321.28/T^2 + 18.0093$. $\log p(\text{total}) = \log p_1(\text{ideal}) + (1946.9/T) \exp(-4351.0/T)$. $\Delta H_{01}^\circ = 21747.0 \pm 10.3$ cal/mole. $D_0 = 11.85 \pm 0.10$ kcal/mole. In the first three equations the pressures are in atmospheres. (auth)

29198 FLUORINE BOMB CALORIMETRY. II. THE HEAT OF FORMATION OF MOLYBDENUM HEXAFLUORIDE. Jack L. Settle, Harold M. Feder, and Ward N. Hubbard (Argonne National Lab., Ill.). *J. Phys. Chem.*, 65: 1337-40 (Aug. 1961).

The heat of formation of molybdenum hexafluoride was measured by direct combination of its elements in a bomb calorimeter. ΔH_f° at 25° of molybdenum hexafluoride gas was found to be -375.3 ± 0.2 kcal mole $^{-1}$. (auth)

29199 THERMAL TRANSPIRATION AT LOW PRESSURE. THE VAPOR PRESSURE OF XENON BELOW 90°K . H. H. Podgurski and F. N. Davis (United States Steel Corp. Research Center, Monroeville, Penna.). *J. Phys. Chem.*, 65: 1343-8 (Aug. 1961).

Thermal transpiration measurements were made with hydrogen, neon, argon and xenon. The pressure ratios for both hydrogen and neon through 2 mm (i.d.) glass tubing

at 5×10^{-4} mm were 8% higher than the limit set by the Knudsen equation $[P_1/P_2 = \sqrt{T_1/T_2}]$. The empirical equation first proposed by Liang also failed to describe the behavior of neon and hydrogen at low pressures. However, the data for xenon and argon, within the limits of experimental error, could be fitted to curves described by this equation. Thermal transpiration values for xenon were determined by vapor pressure measurements. The vapor pressure was measured through glass tubes ranging from 2.00 to 36.3 mm (i.d.); at $T_1 = 77^\circ\text{K}$ and $T_2 = 299^\circ\text{K}$ neither the limit $P_1/P_2 = \sqrt{T_1/T_2} = 0.51$ nor $P_1/P_2 = 1.00$ was realized for xenon vapor in equilibrium with solid xenon for this range of tube diameters; at 90°K the vapor pressure of xenon measured through a 21.7 mm (i.d.) tube needed no transpiration correction, $P_1/P_2 = 1.00$. In the temperature range 85 to 90°K our measured xenon vapor pressure values are described by the equation $\log P(\text{mm}) = -833.33/T + 8.044$. The streaming of mercury vapor from the McLeod gages to the refrigerated traps (195°K) developed pressure gradients in our apparatus which interfered with the measurement of thermal transpiration. With xenon at 10^{-3} mm this mercury drag effected a differential in pressure of 6%. (auth)

29200 PROTON RETENTION IN HEATED 1:1 CLAYS STUDIED BY INFRARED SPECTROSCOPY, WEIGHT LOSS AND DEUTERIUM UPTAKE. V. Stubican and Rustum Roy (Pennsylvania State Univ., University Park). *J. Phys. Chem.*, 65: 1348-51 (Aug. 1961).

Clearcut differences between the weight loss curves automatically recorded by a thermobalance were correlated with the extent of stacking disorder in the kaolin family. The amount of H^+ retained above the initial loss, from $700-1000^\circ$, decreased from the most disordered phase halloysite through the fire-clay-type synthetic kaolinite to large crystals of well-ordered kaolinite. The amount of H^+ retention was determined quantitatively from infrared spectra after resynthesizing the kaolinite with pure D_2O , but not by direct infrared examination. The absorption spectra of specimens of heated kaolinite and pyrophyllite were recorded from $11-25\mu$. The 538 cm^{-1} band in kaolinite, previously assigned by us to some mode of $\text{Si}-\text{O}-\text{Al}$, disappears in the samples heated between $600-950^\circ$ and reappears at higher temperatures. The same band does not disappear in heated pyrophyllite but shifts progressively from 545 to 565 cm^{-1} . These data are compared with present theories concerning coordination changes in heated clays. (auth)

29201 THE COMPARATIVE ROLES OF OXYGEN AND INHIBITORS IN THE PASSIVATION OF IRON. IV. OSMIUM(VIII) OXIDE. G. H. Cartledge (Oak Ridge National Lab., Tenn.). *J. Phys. Chem.*, 65: 1361-7 (Aug. 1961).

Cathodic polarization of iron electrodes after passivation in osmium(VIII) oxide was used as a means of determining the relative contributions of oxygen and the passivating inhibitor to the total cathodic process. It was found that the rate of reduction of osmium(VIII) oxide greatly exceeds that of oxygen. The reduction product, $\text{Os}(\text{OH})_4$, was shown to accelerate the reduction processes, as was found previously with reduction of the pertechnetate ion. A possible mechanism for this action is suggested. The results of the four papers in the series are summarized and discussed in their relation to theories of passivation. (auth)

29202 THE MASS SPECTRUM OF ETHYLLITHIUM VAPOR. Joseph Berkowitz (Argonne National Lab., Ill.), D. A. Bafus, and Theodore L. Brown. *J. Phys. Chem.*, 65: 1380-3 (Aug. 1961).

The saturated vapor of ethyllithium was analyzed by use

of a mass spectrometer. Mass peaks corresponding to $\text{Li}_n\text{R}_{n-1}^+$ ($n = 1, 2, 3, 4, 5, 6$) were observed. The Li_6R_5^+ and Li_4R_3^+ peaks have appearance potentials 3–4 eV lower than any of the others, and were thus assumed to be the only parent ions. Corroborative evidence for this conclusion was obtained by using a double-oven to analyze the under-saturated vapor. The results point to hexamer and tetramer as the predominant species in ethyllithium vapor. (auth)

29203 RARE EARTHS. I. VAPORIZATION OF La_2O_3 AND Nd_2O_3 ; DISSOCIATION ENERGIES OF GASEOUS LaO AND NdO . Harold W. Goldstein, Patrick N. Walsh and David White (Ohio State Univ., Columbus). *J. Phys. Chem.*, 65: 1400–4 (Aug. 1961).

The vaporization of the rare earth oxides, La_2O_3 and Nd_2O_3 , at elevated temperatures was studied by a combination of Knudsen effusion and mass spectrometric techniques. Both vaporize almost stoichiometrically to the monoxide and oxygen. The heats of formation, ΔH_f^0 , in kcal. mole⁻¹, and dissociation energies, D_0^0 , in eV are: LaO , -29.8 ± 4 , 8.08 ± 0.2 ; NdO , -30.0 ± 6 , 7.18 ± 0.3 , respectively. (auth)

29204 RARE EARTHS. II. A MASS SPECTROMETRIC DETERMINATION OF THE HEATS OF SUBLIMATION (OR VAPORIZATION) OF NEODYMIUM, PRASEODYMIUM, GADOLINIUM, TERBIUM, DYSPROSIUM, HOLMIUM, ERBIUM AND LUTETIUM. David White, Patrick N. Walsh, Harold W. Goldstein, and David F. Dever (Ohio State Univ., Columbus). *J. Phys. Chem.*, 65: 1404–9 (Aug. 1961).

A time-of-flight mass spectrometer was adapted for thermodynamic investigations at elevated temperatures. The apparatus is described in detail. The heats of sublimation (or vaporization) of several rare earth metals were determined by the mass spectrometric method, from the variation with temperature of the intensity of an atomic beam effusing from a Knudsen cell, in the temperature range 1253 to 2044°K. (auth)

29205 RARE EARTHS. III. A MASS-SPECTROMETRIC INVESTIGATION OF THE ISOMOLECULAR OXYGEN-EXCHANGE REACTIONS OF LANTHANUM, CERIUM, PRASEODYMIUM AND NEODYMIUM WITH THEIR MONOXIDES. Patrick N. Walsh, David F. Dever, and David White (Ohio State Univ., Columbus). *J. Phys. Chem.*, 65: 1410–13 (Aug. 1961).

The equilibrium constants for the reactions $\text{Ce(g)} + \text{LaO(g)} \rightleftharpoons \text{La(g)} + \text{CeO(g)}$ (1); $\text{Pr(g)} + \text{LaO(g)} \rightleftharpoons \text{La(g)} + \text{PrO(g)}$ (2); and $\text{Nd(g)} + \text{PrO(g)} \rightleftharpoons \text{Pr(g)} + \text{NdO(g)}$ (3) and their temperature dependence were determined with a time-of-flight mass spectrometer. The heats of the three reactions in kcal mole⁻¹ calculated from the results are: $\Delta H_1(1870^\circ\text{K}) = 1.05 \pm 0.02$, $\Delta H_2(1913^\circ\text{K}) = 15.8 \pm 0.4$, $\Delta H_3(1910^\circ\text{K}) = 6.9 \pm 0.6$. These heats of reaction give directly the difference in dissociation energies, at the indicated temperatures, of the two gaseous monoxides in each of the reactions. The dissociation energies at absolute zero D_0^0 in eV calculated from these results and appropriate thermal functions are $D_0^0(\text{CeO}) = 8.03 \pm 0.2$, $D_0^0(\text{PrO}) = 7.40 \pm 0.3$, $D_0^0(\text{NdO}) = 7.06 \pm 0.2$. The electronic contributions to the entropy of the gaseous monoxides at elevated temperatures are discussed in terms of the measured entropy changes in the above reactions. (auth)

29206 DIFFUSION OF OXYGEN IN SINGLE CRYSTALS OF NICKEL OXIDE. Michael O'Keefe and Walter J. Moore (Indiana Univ., Bloomington). *J. Phys. Chem.*, 65: 1438–9 (Aug. 1961).

The diffusion of O^{18} was measured in monocrystalline NiO by following the exchange of gaseous oxygen enriched in O^{18} with the NiO crystals. At an oxygen pressure $P_{\text{O}_2} =$

50 mm, from 1100 to 1500°, $D_{\text{NiO}}^0 = 1.0 \times 10^{-5} \exp(-54 \text{ kcal/RT}) \text{ cm}^2\text{sec}^{-1}$. The D_{NiO}^0 increases with P_{O_2} . The most reasonable mechanism for the oxygen diffusion is believed to be by way of interstitial oxygen atoms. (auth)

29207 ELECTRON IMPACT SPECTROSCOPY OF NITROGEN DIOXIDE. Robert W. Kiser and I. C. Hisatsune (Kansas State Univ., Manhattan). *J. Phys. Chem.*, 65: 1444–6 (Aug. 1961).

The appearance potentials of NO^+ and NO_2^+ , formed in the process of electron impact, were determined. The following values were obtained: $\text{NO}_2^+ = 11.2 \pm 0.1$; $\text{NO}^+ = 12.4 \pm 0.4$; and NO^+ vs $\text{NO}_2^+ = 1.16 \pm .08$. Using the value 12.48 eV for $\text{IP}(\text{NO}^+)$ from NO_2 and the literature value of $\text{IP}(\text{NO}^+) = 9.25 \text{ eV}$, the nitrogen–oxygen bond energy in nitrogen dioxide was calculated, $D(\text{O–NO}) = 3.2 \text{ eV}$ or 74 kcal/mole. (P.C.H.)

29208 CONFIRMATION OF DISORDER IN SOLID NITROUS OXIDE BY NEUTRON DIFFRACTION. Walter C. Hamilton and Martha Petrie (Brookhaven National Lab., Upton, N. Y.). *J. Phys. Chem.*, 65: 1453–4 (Aug. 1961). (BNL-5147)

A disordered structure, which rests entirely on thermodynamic data and leaves the possibility that the structure is ordered and that the excess entropy arises from some other source, has been postulated from x-ray diffraction studies. Therefore, the diffraction experiment was repeated with neutrons where the more favorable ratio of scattering factors ($b_{\text{O}} = 0.58$, $b_{\text{N}} = 0.94$) allows a more sensitive test of any departures from the disordered model. Intensities were calculated for several sets of structure parameters for the disordered model (space group $\text{Pa}\bar{3}$) and also for the ordered model. It was concluded that the completely ordered model was incompatible with the neutron diffraction data. (P.C.H.)

29209 THE RESIDUAL ENTROPY OF THE EQUIMOLAL KCL–KBR SOLID SOLUTION IN RELATION TO WASASTJERNA'S THEORY OF ALKALI HALIDE SOLID SOLUTIONS. M. V. Milnes and W. E. Wallace (Univ. of Pittsburgh). *J. Phys. Chem.*, 65: 1456–7 (Aug. 1961).

Using the ΔC_p 's for the temperature range 12 to 300°K, the residual entropy was computed to be $1.39 \pm 0.04 \text{ eu}$ or $1.37 \pm 0.04 \text{ eu}$. The values, which are very close to the entropy of random mixing, strongly suggest that there is a negligible amount of local order in the anion sublattice. The results are at variance with Wasastjerna's theory which predicts a residual entropy of $1.29 \pm 0.01 \text{ eu}$ and an appreciable degree of order. The results show that when $\text{KCl}_{0.5}\text{Br}_{0.5}$ is formed from the component salts, there is an increase in vibrational entropy of 0.11 eu. (P.C.H.)

29210 PHASE EQUILIBRIA IN THE BINARY SYSTEMS PuCl_3 – RbCl AND PuCl_3 – CsCl . R. Benz and R. M. Douglass (Los Alamos Scientific Lab., New Mex.). *J. Phys. Chem.*, 65: 1461–3 (Aug. 1961).

The results of cooling-curve analyses for the systems PuCl_3 – RbCl and PuCl_3 – CsCl , confirmed by microscopic examinations of the quenched products, indicate the existence of three double salts and two double salts, respectively. The results for both systems are summarized in phase diagrams. (P.C.H.)

29211 VAPOR PRESSURES OF PLATINUM, IRIDIUM, AND RHODIUM. R. F. Hampson, Jr. and R. F. Walker. *J. Research Natl. Bur. Standards*, 65A: 289–95 (July–Aug. 1961).

The vapor pressures of platinum, iridium, and rhodium were measured using a microbalance technique based on the Langmuir method. Heats of sublimation at 298°K were

calculated with the aid of free energy functions. The least square lines for the vapor pressure data, the heats of sublimation, and the normal boiling points are given. (auth)

29212 PHASE EQUILIBRIUM RELATIONS IN THE BINARY SYSTEM BARIUM OXIDE-NIOBIUM PENTOXIDE. S. Roth and J. L. Waring. J. Research Natl. Bur. Standards, 65A: 337-44 (July-Aug. 1961).

A large portion of the phase equilibrium diagram was constructed from observations of fusion characteristics and x-ray diffraction data. In the system, five binary compounds were observed with $\text{BaO}:\text{Nb}_2\text{O}_5$ ratios of 5:2, 1:1, 6:7, 3:5, and 1:3 and a 6:1 compound was postulated. The 6:1 compound was found to melt congruently at 1455°C and have only one stable polymorph, although a second metastable polymorph can also be prepared. The 5:2 compound melts congruently at 1542°C; the 6:7, 3:5, and 1:3 phases melt incongruently at 1330, 1290, and 1315°C, respectively. The phase relations of the 6:1 compound could not be determined due to the reaction between the phase and platinum metal. No 2:1 compound was observed in the system. (auth)

29213 SOLID STATE REACTIONS INVOLVING OXIDES OF TRIVALENT CATIONS. S. J. Schneider, R. S. Roth, and J. L. Waring. J. Research Natl. Bur. Standards, 65A: 445-74 (July-Aug. 1961).

Selected mixtures in 69 binary systems involving Al_2O_3 , Ga_2O_3 , Cr_2O_3 , Fe_2O_3 , Sc_2O_3 , In_2O_3 , Y_2O_3 , and the rare earth oxides were studied by x-ray diffraction techniques after heat treatment at various temperatures. A plot of the radii of the A^{3+} cations versus the radii of B^{3+} cations shows the regions of stability for the different structure types found for the double oxides of the trivalent cations. The following structure types were encountered: A, B, and C-type rare earth oxide; corundum, beta gallia; kappa alumina; garnet; perovskite; and several types which could not be definitely related to known structures. The majority of $\text{A}^{3+}\text{B}^{3+}\text{O}_3$ compounds have the perovskite structure. Several phases, including $(1-x)\text{Fe}_2\text{O}_3 \cdot x\text{Al}_2\text{O}_3$ and $(1-x)\text{Fe}_2\text{O}_3 \cdot x\text{Ga}_2\text{O}_3$, appear to have structures similar to kappa alumina. Solid solution definitely occurs in many of the garnet type compounds which contain gallia. Based on the data collected in this survey, the subsolidus phase equilibria relationships of 79 binary systems were drawn. (auth)

29214 SECOND-ORDER EFFECT OF SPIN-ORBIT INTERACTION ON THE PARAMAGNETIC RESONANCE SPECTRA OF IONS WITH A SINGLE 3d ELECTRON. D. K. Ray (Moscow State Univ.). Nuovo cimento (10), 21: 1-6 (July 1, 1961). (In English)

In order to explain in a better way the covalent bonding factors for ions with a single 3d electron, the second-order g-factors, arising out of the mixing of orbital doublet states with orbital triplet states through spin-orbit interaction, are reevaluated for crystal fields of different symmetries. On the basis of these expressions, discussions are made about the EPR spectra of Ti^{3+} in some salts and of V^{4+} in TiO . (auth)

29215 ELECTRICALLY INDUCED SHIFT OF THE F^{19} RESONANCE FREQUENCY IN MnF_2 . P. S. Pershan and N. Bloembergen (Harvard Univ., Cambridge, Mass.). Phys. Rev. Letters, 7: 165-7 (Sept. 1, 1961).

The predicted linear effect of an applied electric field on the magnetic hyperfine interaction was found experimentally in antiferromagnetic MnF_2 . The F^{19} resonance, which occurs at 159.970 mc/sec without external magnetic field at 4.2°K, was detected with the Kushida spectrometer. Results are an order of magnitude smaller than the theoretical estimate. Reasons for discrepancies in the theory are pointed out. (L.N.N.)

29216 DENSITY OF LIQUID IRON SILICATES. John Henderson, R. G. Hudson, R. G. Ward, and G. Derge (Carnegie Inst. of Tech., Pittsburgh). Trans. Met. Soc. AIME, 221: 807-11 (Aug. 1961).

Densities of melts of the iron oxide-silica system in contact with solid iron have been measured by the maximum bubble pressure method in the composition range 0 to 37 wt. % SiO_2 and the temperature range 1255° to 1410°C. The constitution of the melts is discussed, and it is postulated that the structure changes from a distribution of iron ions in an oxygen ion network at pure "FeO" to a distribution of iron ions in a network of silicate tetrahedra at the orthosilicate composition. (auth)

29217 THERMODYNAMIC CONSIDERATIONS IN THE CHLORINATION OF DIFFERENT OXIDES CONSTITUTING COLUMBITE (NIOBITE) AND TANTALITE. G. V. Jere, C. C. Patel, and V. Krishnan (Indian Inst. of Science, Bangalore). Trans. Met. Soc. AIME, 221: 866-72 (Aug. 1961).

Standard free energy and standard enthalpy changes as a function of temperature have been calculated for the chlorination reactions of different oxides constituting niobite and tantalite. The values of standard free-energy change (ΔF_T^0) indicate the possibility of preferential chlorination of different oxides but the ease of chlorination of niobium pentoxide at about 250°C and the chlorinating tendency of niobium pentachloride in promoting the chlorination of tantalum and other metal oxides, prevent the separation of niobium and tantalum from other oxides and from each other. It is likely that low temperatures of chlorination and continuous removal of niobium pentachloride from the reaction zone may help partial separation of niobium from tantalum as well as from titanium. The standard enthalpy change (ΔH_T^0) values show that low-temperature chlorination around 300° to 500°C is likely to sustain the chlorination reactions without external heating. (auth)

Radiation Chemistry and Radiochemistry

29218 (DRCL-345) ELECTROCHEMICAL RADIATION DOSIMETRY. I. H. S. Henderson (Canada. Defence Research Chemical Labs., Ottawa). Mar. 1961. 32p.

The change in the potential of an aqueous redox solution during irradiation is, under certain conditions, a very sensitive analytical method for determining the amount of chemical change taking place. Use was made of this phenomenon in the design of a chemical dosimeter in which dose is read as a potential difference. An essential part of the dosimeter is a compartment sealed by one or more glass electrode membranes through which electrolysis and potential measurement can be carried out. Some experimental results are presented which demonstrate the feasibility of the system as an integrating chemical dosimeter in the range 5 to 10000 rads. By passage of an electric current through the dosimeter, the chemical change produced in solution during irradiation is reversed, thus restoring the solution to its pre-irradiation state. The possibility of determining radiation yields is considered. (auth)

29219 (NAS-NS-3039) THE RADIOCHEMISTRY OF NIOBIUM AND TANTALUM. Ellis P. Steinberg (Argonne National Lab., Ill.). May 1961. 61p.

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

A review is presented of the chemical and nuclear fea-

tures of particular interest to the radiochemist, and problems in counting techniques and sample dissolution. A collection of radiochemical procedures for the elements as found in the literature is included. (B.O.G.)

29220 (NAS-NS-3040) THE RADIOCHEMISTRY OF LEAD. W. M. Gibson (Bell Telephone Labs., Murray Hill, N. J.). Aug. 1961. 232p.

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

Standard radiochemical procedures for Pb are given and are used as the basis of several detailed radiochemical procedures for this element which are compiled. Techniques which appear to have promise but are not in general use are also discussed. (J.R.D.)

29221 (NAS-NS-3041) THE RADIOCHEMISTRY OF COBALT. L. C. Bate and G. W. Leddicotte (Oak Ridge National Lab.). 1961. 94p.

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

The radiochemistry of cobalt is discussed. Included are a review of the nuclear and chemical features of cobalt, a discussion of problems of dissolution of a sample and counting techniques, and a collection of radiochemical procedures for the element as found in the literature. (M.C.G.)

29222 (NAS-NS-3042) THE RADIOCHEMISTRY OF TUNGSTEN. W. T. Mullins and G. W. Leddicotte (Oak Ridge National Lab.). 43p.

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

The radiochemistry of tungsten is discussed. A review of its nuclear and chemical features, a discussion of problems of dissolution of a sample and counting techniques, and a collection of radiochemical procedures for the element as found in the literature are presented. (M.C.G.)

29223 (NYO-9829) A STUDY OF THE MECHANISM OF RADIATION-INDUCED GELATION IN MONOMER-POLYMER MIXTURES. Quarterly Summary Report, May 1-July 31, 1961. George Odian, Bruce S. Bernstein, and James J. Kelly (Radiation Applications Inc., Long Island City, N. Y.). Aug. 8, 1961. Contract AT(30-1)-2816. 35p.

Gel contents of irradiated polyethylene previously swollen with fourteen different di- and tri-functional monomers were accurately measured. Eight of these monomers are useful in reducing the radiation dose required to induce gelation. Allyl acrylate and allyl methacrylate produce the largest gel fractions (~40%) after a dose of 1.2 mrad on the Co^{60} source; these two monomers also swell polyethylene to a greater extent than the others. The degree of desorption of the above monomers from polyethylene during irradiation were measured. Machine irradiation of polyethylene-allyl acrylate and polyethylene-allyl methacrylate systems give higher gel contents (~60%) than are obtained under Co^{60} irradiation conditions. This is probably due to the fact that desorption of these monomers is less under machine irradiation conditions. Continuous reswelling and reirradiation of polyethylene-allyl acrylate and polyethylene-allyl methacrylate systems give gel contents of about 80% after four cycles. After each cycle, an increased amount of monomer is incorporated into the polymer by swelling, while the increase in gel content becomes smaller. Swelling ratios of irradiated polyethylene-monomer combinations were also measured. (auth)

29224 (AEC-tr-4798) EFFECT OF IRRADIATION ON THE EXCHANGE REACTION BETWEEN TRITIUM AND ORGANIC COMPOUNDS. PART III. Fulvio Cacace and

Elvira Possagno. Translated by E. U. Kauer for Savannah River Lab., Aiken, S. C., from Gazz. chim. ital., 90: 1800-6 (1960). 6p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 20743.

29225 (CEA-tr-R-1313) ETUDE DE L'ACTION DU RAYONNEMENT EXTERNE SUR LE TAUX D'ECHANGE ISOTOPIQUE DE SULFURE DANS LE SYSTEME $\text{K}_2\text{SO}_4\text{-SO}_3$ A HAUTES TEMPERATURES. (Study of the Action of External Radiation on the Isotopic Exchange Rate of Sulfur in the $\text{K}_2\text{SO}_4\text{-SO}_3$ System at High Temperatures). V. I. Spitsyn (Spitzine), I. E. Mikhailenko, I. V. Vereschinskii, and P. Ya. Glazunov. Translated into French from Doklady Akad. Nauk S.S.S.R., 131: 360-3 (1960). 10p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, Abstract No. 16667.

29226 (SCL-T-379) CHEMICAL EFFECTS OF IRRADIATION BY HEAVY PARTICLES: USE OF THE FERROUS SULFATE-LITHIUM SULFATE SYSTEM AS A SIMULTANEOUS DOSIMETER OF THERMAL NEUTRONS AND OF IONIZING RADIATIONS. I. Draganic and J. Sutton. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.) from J. chim. phys., 52: 327-30 (Apr. 1955). 8p.

In order to study the action of different heavy particles of high energy on certain aqueous systems, the products of the nuclear reaction $\text{Li}^6(n,\alpha)\text{H}^3$ were utilized as ionizing agents. The results are presented for the oxidation of the solutions of the double sulfate of iron II and of ammonium (Mohr's salt) in sulfuric acid 0.8N, containing also lithium sulfate. The oxidation was studied quantitatively as a function of the concentration in lithium and of the dose of neutrons. The results showed that the system "lithium sulfate-ferrous sulfate" can serve as a specific dosimeter for the thermal neutrons in the presence of other ionizing radiations, or as a total dosimeter when the ratio of the thermal neutrons to the other radiations remains constant. (auth)

29227 NEUTRON AND γ -IRRADIATION OF PROPIONAMIDE. Enzo Tachikawa and Gen-ichi Tsuchihashi (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan, 34: 770-4 (June 1961). (In English)

Two methylation reactions of propionamide by the C^{14} -hot atom, and of methyl radical from Co^{60} γ -ray irradiation and methylation reaction of propionic acid by methyl radical from thermal decomposition of acetyl peroxide were carried out, and the reactivities of these species were studied. The methyl radical produced by Co^{60} γ irradiation of propionamide gave the 3:2 mixture of butyr- and isobutyramide. This ratio agrees with the activity distribution of butyr- and isobutyramide in the neutron irradiation of propionamide. On the other hand the methyl radical produced by the thermal decomposition of acetyl peroxide in propionic acid gave a 1:2 mixture of butyric and isobutyric acid. From these results, the reactions in the neutron and in the γ irradiation are considered to be high energy reactions, whereas the methylation reaction of acetyl peroxide in propionic acid is considered to be a free radical reaction. (auth)

29228 THE PREPARATION OF THE MOST IMPORTANT RADIOELEMENTS. Y. Jolchine. Bull. inform. sci. et tech. (Paris), No. 51, 34-40 (May 1961). (In French)

The preparation and analysis of the more important radioisotopes are described. The elements discussed are I^{131} , P^{32} , S^{35} , C^{14} , Cr^{51} , Cu^{64} , and Zn^{65} . (J.S.R.)

29229 SYNTHESIS OF LABELED MOLECULES. M. Herbert and L. Pichat. Bull. inform. sci. et tech. (Paris), No. 51, 41-5 (May 1961). (In French)

In the Section des Molécules Marquées an increasing number of labeled compounds are produced. The labeling atoms used are C^{14} , S^{35} , T , N^{15} , and D . An indication is given of the chemical procedures used and the possible difficulties. (J.S.R.)

29230 THE EFFECT OF ACIDITY ON THE RADIATION CHEMICAL YIELD. V. N. Shubin and P. I. Dolin (Electrochemical Inst., Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 139: 154-7 (July 1, 1961). (In Russian)

Ordinarily the radiation chemical yield of a reaction as a function of the acidity of the solution is qualitatively explained by postulating a very fast equilibrium of the following type: $H + H^+ \xrightleftharpoons{K_a} H_2^+$. However, values of pK_a varying from 0 to 3 are obtained for different substances, and the dependence of the yield on the concentration of the acceptor cannot be explained in this way. These difficulties disappear if it is assumed that the acceptor can compete with the H^+ ion for H atoms, and also for H_2^+ molecules: 1) $H + A_c \xrightleftharpoons{K_b}$ products and 2) $H_2^+ + A_c \xrightleftharpoons{K_c}$ products. This mechanism was used in order to describe quantitatively the oxidation and reduction of a mixture of Fe^{2+} and Fe^{3+} in a solution saturated with H_2 under pressure as a function of the pH of the solution on irradiation with Co^{60} . Since Fe^{3+} exists in H_2SO_4 solution in the form of a complex, the yields were also determined in perchloric acid solutions. The data of other investigators were also considered, and it was shown that the proposed mechanism can satisfactorily explain the radiation yield as a function of acidity in a number of different systems. (TTT)

29231 THE OXIDATION AND REDUCTION OF ORGANIC COMPOUNDS BY THE RADICAL PRODUCTS OF THE RADIOLYSIS. V. A. Larin and N. A. Bakh (Inst. of Electrochemistry, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 139: 406-9 (July 11, 1961). (In Russian)

The action of radiation was investigated on solutions of methylene blue (MB) and the leuco form of methylene blue (LMB) at concentrations of 10^{-6} M to 10^{-1} M in acetone, nitromethane, methanol, ethanol, n-propanol, n-butanol, formamide, pyridine, N-methylformamide and N, N-dimethylformamide. All solutions were sealed in ampoules under an atmosphere of nitrogen, irradiated and subjected to spectrophotometry in the same ampoule. In solutions of acetone, nitromethane, and methanol, LMB is oxidized to MB, and the radiation yield of the reaction can be calculated from the linear increase in the concentration of MB with dose up to 5000 to 7000 rads. The yield for the reduction of MB in methanol is $G(R_{red}) = 2.8$ and for the oxidation of LMB it is $G(R_{ox}) = 3.6$. Methylene blue is not always reduced to the leuco form, as shown by the fact that the full intensity of the original color of the methylene blue solution is not restored on passing oxygen through the solution. Three cases can be distinguished. There is a completely reversible reduction of MB to LMB in formamide, a partial irreversible decolorization in N-methyl formamide, and a totally irreversible decolorization in N, N-dimethylformamide. Only oxidation of LMB occurs in nitromethane. Oxidation of LMB and reduction of MB take place to an equal degree in methanol. Only reversible reduction of MB to LMB occur in the normal aliphatic alcohols (except for methanol), formamide and pyridine. The direct effect of radiation on the solute can be neglected at concentrations of 10^{-2} M and lower. All processes in this case are determined by the interaction of an acceptor with the radiolysis products of the solvent. The limiting yield of MB is very high ($G \sim 13$) in acetone, and this high yield may be partially due to the presence of excited acetone molecules in the irradiated solution. (TTT)

29232 THE CONVERSION OF THE OXIDATIVE COMPONENT OF RADIOLYSIS IN THE NITRATE-WATER SYSTEM. M. A. Proskurnin, V. A. Sharpatyi, V. I. Smirnova, N. M. Pomerantsev, G. N. Kuz'mintseva, and T. A. Simonova (Karpov Inst. of Physics and Chemistry, [USSR]). Doklady Akad. Nauk S.S.S.R., 139: 410-13 (July 11, 1961). (In Russian)

In order to determine the role of the OH radical in the radiolytic reduction of the nitrate ion in alkaline solutions, the kinetics of the accumulation of H_2O_2 and O_2 in 1 M NaOH were followed. The analysis of O_2 and H_2 were carried out in alkaline and acid solutions, while the analysis for H_2O_2 was carried out only after adjusting the pH of the solution to ~ 5 . A G value of 2.2 was obtained for the yield of H_2O_2 if the irradiated 1 M NaOH is acidified immediately after irradiation to a pH of ~ 5 , and an analysis for H_2O_2 is made immediately. No H_2O_2 could be detected in the 1 M NaOH solution itself. In general, the sum of the yields of the reducing component of the radiolysis (G_H) is twice as high on a yield balance as the sum of the yields of the oxidative component of the radiolysis (G_{OH}). The concentration of nitrite ion in alkaline solution is higher than it is after acidification, and a better balance in the conversion products of the H and OH radicals is observed at a pH ~ 2 to 3. It is hypothesized that OH radicals can exist in alkaline solutions and have an effect on the yield of the final products under definite conditions. Possibly, a dimer of $OH \cdot NO_2^-$ is formed in alkaline solution. The presence of intermediate, paramagnetic radiolysis products was detected in the irradiated alkaline solution by using the method of nuclear magnetic resonance. It is concluded that the paramagnetic intermediate is formed as a result of the interaction of the oxidative component of the radiolysis of water with nitrate and alkali. (TTT)

29233 THE NATURE AND THE STRENGTH OF CROSSLINKAGES OF RADIATION-VULCANIZED POLY-SILOXANE RUBBERS. I. Ya. Poddubnyi, S. V. Aver'yanova and L. A. Aver'yanova (Lebedev All-Union Synthetic Rubber Research Inst., [USSR]). Doklady Akad. Nauk S.S.S.R., 139: 651-3 (July 21, 1961). (In Russian)

It has been shown previously that irradiation of dimethyl- and of polymethyl vinyl siloxane containing about 0.1% vinyl groups results in materials with increased heat resistance. Addition of a transition metal to the SiO_2 in the batch mixture further increases the heat resistance. This is due not only to the continued presence of the catalyst in the peroxide type vulcanizates but to a basic change in the lattice structure: the structure formed during radiation is more liable to form double bonds. Addition of transition metals to siloxanes contributes to the formation of secondary radiation centers which help to reduce the lattice defects, thus increasing the strength. The Si-C bond strength is higher than it could be anticipated from the energy of decomposition of the bond (57.6 kcal); this is due to the intermolecular forces generated by the radiation in the polymer and between the polymer and the filler. Similar results were obtained when the irradiation was carried out in vacuum. (TTT)

29234 EFFECT OF THE RADIOACTIVITY OF MOLYBDENUM TRIOXIDE ON ITS SUBLIMATION RATE. Vikt. I. Spitsyn and I. E. Zimakov (Inst. of Physical Chemistry, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 139: 654-7 (July 21, 1961). (In Russian)

The rate of sublimation of MoO_3 preparations containing various amounts of 68.3-hr half-life, β -active Mo^{99} was studied by determining the weight losses of the 300-mg test samples heated to 700°C in a current of dry air. The specific activity of the samples was varied from 1 to 28

millicuries/g. Up to an activity level of 2.5 millicuries/g the difference in the rate, as compared with the inactive sample was found to be negligible. Increasing the activity to 4 millicuries/g the rate was slightly decreased. Upon further increase of the activity, up to 9 millicurie/g the sublimation rate increased markedly, followed by a slowing down with continued rise of the activity of the preparation. This behavior is attributed to the effect of the surface charge. The central Mo atom is surrounded by 3 negatively charged O atoms, therefore the positive charge of the solid MoO_3 due to the β -emission impedes the passage into the vapor phase. This was proved by introducing a grounded Pt wire into the system: the previously noticed minimum disappeared. Radioactive phenomena in the gas phase also play a role. The β -flux ionizes the MoO_3 molecules which then are repulsed by the solid surface. Irradiation by an external 800-Mev electron flux has no noticeable effect on the sublimation rate below 10^{16} ev/g sec. (TTT)

29235 THE $I^{1/2}$ LAW IN THE RADIOLYTIC OXIDATION OF IRON ATOMS BY HYDROGEN ATOMS AND THE MECHANISM OF THE PROCESS. B. V. Ershler and V. G. Firsov. *Doklady Akad. Nauk S.S.S.R.*, 139: 662-4 (July 21, 1961). (In Russian)

The model based on the $I^{1/2}$ law which was previously found useful for similar studies (B. V. Ershler, *Doklady Akad. Nauk SSSR*, 139: (1961) No. 4), was used for determining the oxidation mechanism of Fe^{2+} by H atoms during radiolysis. Solutions containing various amounts of FeSO_4 in 0.8 N H_2SO_4 were irradiated by a Co^{60} source, and determining the oxidation yield G under various conditions of pH and flux. G was found to be only slightly dependent on the FeSO_4 concentration; it decreased with increasing pH. Changing the radiation flux from I_1 to I_2 , the curve of G vs $\log [H^+]$ shifts on the logarithmic axis without changing its shape by the amount of $\log (I_2/I_1)^{1/2}$. The decrease of G with pH indicates that the rate of recombination of the oxidizing radicals exceeds their capture by the acceptor H^+ ions. Lowering the radiation level I, thus increasing the distance between tracks, G is increased because the recombination of radicals from different tracks is thereby made more difficult. (TTT)

29236 ON THE THERMOCHEMICAL ACTION OF IONIZING RADIATION. V. I. Goldanskii and Yu. M. Kagan (Academy of Sciences, Moscow). *Intern. J. Appl. Radiation and Isotopes*, 11: 1-9 (Aug. 1961). (In English)

General characteristics of the thermochemical action of ionizing radiation are considered. The following problems are treated: (1) determination of the maximum (quasi-equilibrium) thermochemical action of radiation; (2) determination of the amount of heat spent in an endothermic reaction within a microvolume along the ionizing particle track; (3) determination of the total efficiency for a quasi-stationary case of averaged heating up of a mixture; (4) determination of the energy imparted to the reaction by a narrow beam of charged particles coaxial to a cylindrical volume. The results obtained may also be of some interest for discussing the problems of annealing and retention effects upon nuclear transformations in solids. (auth)

29237 THE RADIATION-INDUCED GRAFT COPOLYMERIZATION OF 4-VINYL PYRIDINE TO TERYLENE. M. R. Houlton and J. K. Thomas (Wantage Radiation Lab., Berks, Eng.). *Intern. J. Appl. Radiation and Isotopes*, 11: 45-7 (Aug. 1961). (In English)

The method and mechanism of radioinduced graft copolymerization of 4-vinyl pyridine to Terylene filament yarn fabric, polyacrylonitrile, and polyethylene are described.

The best results are obtained when the dry fabric is irradiated in air and is followed by reacting 4-vinyl pyridine with the fabric in the absence of oxygen. The 4-vinyl pyridine is applied to the fabric as a 2% aqueous solution. Graphs are given showing the effect of temperature on the rate of grafting of 4-vinyl pyridine to Terylene at a dose of 1.5 Mrad and the effect of dose rate on grafting. Results show that dyeability and antistatic finish are improved by the irradiation process. (N.W.R.)

29238 EFFECTS OF RADIOACTIVITY OF SOLIDS ON CATALYTIC PROPERTIES. A. A. Balandin, V. I. Spitsyn, N. P. Dobrosel'skaya, I. E. Mikhailenko, I. V. Vereshchinskii, and P. Ya. Glazunov (Inst. of Physical Chemistry, Academy of Sciences, USSR and Moscow State Univ.). *Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk*, No. 4, 565-71 (Apr. 1961). (In Russian)

The influence of magnesium and sodium sulfates and potassium chloride, containing S^{35} and Ca^{45} , on cyclohexanol dehydration was investigated. Various factors indicate an increased catalytic activity in comparison with non-radioactive catalysts. The catalytic activity diminishes with S^{35} and Ca^{45} decay. Fast electron (800 kev) bombardment of nonradioactive catalysts and the S^{35} and Ca^{45} β particles produce almost identical effects. (R.V.J.)

29239 UNSATURATION IN IRRADIATED MARLEX 50 POLYETHYLENE: DOSE RATE AND POST-IRRADIATION EFFECTS. P. J. Fydeler (Wantage Research Labs., Berks, Eng.) and R. W. Pearson. *J. Appl. Polymer Sci.*, 5: 171-4 (Mar.-Apr. 1961).

Infrared absorption spectroscopy was used to demonstrate dose rate dependence of trans-vinylene unsaturation in irradiated Marlex 50 polyethylene. When the irradiated polymer is stored in vacuum a decrease is observed in trans-vinylene absorbance over a period of several weeks. After high dose rate irradiation the decay is preceded by an initial increase. These phenomena are ascribed to the reaction of trapped radicals. (auth)

29240 STUDIES ON THE γ -IRRADIATION OF NATURAL RUBBER LATEX. Yuji Minoura (Osaka City Univ.) and Mamoru Asao. *J. Appl. Polymer Sci.*, 5: 233-9 (Mar.-Apr. 1961).

Vulcanized latex was obtained by the γ irradiation of natural rubber latex. The optimum cure was attained with ca 2×10^7 r, in the case of 40% latex. Due to the acceleration action of the water present, rubber in latex crosslinked more easily than it did in previously dried latex film, but no appreciable difference was found between the crosslinking in lattices of various water contents. The protein in the latex deteriorated under γ irradiation, but the properties of the latex were not damaged. The maximum tensile strength of the film obtained by drying the irradiated latex was larger than that of solid rubber irradiated in air; this may correspond to the fact that the irradiation, even when carried out in air, brought about no side reactions such as oxidation, of rubber in latex. The aging behavior of the irradiated film was quite superior, the tensile strength being greater after aging than before. (auth)

29241 A PARAMAGNETIC SPECIES IN IRRADIATED NaNO_2 . Henry Zeldes and Ralph Livingston (Oak Ridge National Lab., Tenn.). *J. Chem. Phys.*, 35: 563-7 (Aug. 1961).

Single crystals of sodium nitrite were irradiated with Co^{60} gamma rays at 77°K and studied by the paramagnetic resonance method. An anisotropic three-line hyperfine spectrum associated with a single paramagnetic species was observed. The hyperfine structure arises from a nitrogen nucleus in the paramagnetic species at a position of mm point symmetry. The principal values of the g ten-

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sor and the hyperfine tensor were deduced as well as the directions of their principal axes. The paramagnetic species is believed to be NO_2 . (auth)

29242 DOUBLE AND TRIPLE IONIZATION IN MOLECULES INDUCED BY ELECTRON IMPACT. F. H. Dorman and J. D. Morrison (C.S.I.R.O., Melbourne). *J. Chem. Phys.*, 35: 575-81 (Aug. 1961).

Double and triple ionization by electron impact in molecules is examined and, as was found for the monatomic gases, the data support the view that the threshold law for the probability of double ionization is a square-law function of the excess electron energy. Some excited states were detected, and autoionization does not seem to be important. The vertical potentials for all the processes of multiple ionization observed were measured. The relative electronic-transition probabilities for single, double, and triple ionization are compared. The factors affecting the stability of multiply charged molecular ions are discussed, and an attempt is made to correlate the electron impact data with the molecular structures. It is shown that Coulomb repulsion between the separated charges causes the potential energy functions describing these ions to be of unusual form. (auth)

29243 RADIOLYSES BY TRANSFERRED ENERGY OF COMPOUNDS DISPERSED IN ALKALI HALIDE MATRICES. A. Russell Jones (Oak Ridge National Lab., Tenn.). *J. Chem. Phys.*, 35: 751-2 (Aug. 1961).

Pressed potassium bromide disks were used in an analysis of irradiations performed in a current of dry helium with cobalt-60 gamma rays or 1.5 Mev electrons from a Van de Graaff generator. A comparison of the disappearance of NO_2^- from duplicate disks allowed an estimation of the energy absorbed during electron bombardment. The rate thus determined was not the same as that obtained in the radiolysis of pure material, and it was necessary to assume that chemical changes in the system were largely initiated by transferred energy. Calculated initial G's for the disappearance of substances are given. (L.N.N.)

29244 ELECTRON SPIN RESONANCE OF X-RAY IRRADIATED SINGLE CRYSTALS OF GLUTAMIC ACID HYDROCHLORIDE. W. C. Lin, C. A. McDowell, and J. R. Rowlands (Univ. of British Columbia, Vancouver). *J. Chem. Phys.*, 35: 757-8 (Aug. 1961).

Results of studies of the electron spin resonance spectra of the radicals formed in the irradiation of single crystals of glutamic acid-HCl with 50 kv x rays at room temperature are reported. The presence of a beta-succinyl type radical was identified. (L.N.N.)

29245 TRITIUM AS AN INTERNAL SOURCE OF RADIATION IN EPR STUDIES ON ORGANIC MATERIALS. J. Kroh and J. W. T. Spinks (Univ. of Saskatchewan, Saskatoon). *J. Chem. Phys.*, 35: 760-1 (Aug. 1961).

Tritium was used as an internal source of radiation in H_2O and D_2O ice and frozen aqueous solutions. Small quantities of aqueous T_2O at 1 c/ml were introduced into liquid organic materials. The samples were then frozen in liquid nitrogen and their electron paramagnetic spectra recorded. Results are given. (L.N.N.)

29246 ESR SPECTRA OF A GAMMA-IRRADIATED SINGLE CRYSTAL OF DL-SERINE. D. V. G. L. Narasimha Rao and Walter Gordy (Duke Univ., Durham, N.C.). *J. Chem. Phys.*, 35: 764-5 (Aug. 1961).

Single crystals of DL-serine $\text{HOCH}_2\text{CH}(\text{NH}_2)\text{COOH}$ were grown by slow evaporation of aqueous solutions. The crystals, with monoclinic symmetry, were given gamma doses of the order of 10^7 r at room temperature. The in-

duced electron spin resonance was observed at 9 k Mc/sec. Spectra of the ESR are represented graphically and nuclear coupling values are presented in tabular form. (L.N.N.)

29247 THE RADIOLYSIS OF BIACETYL VAPOR. Gilbert J. Mains, Amos S. Newton, and Aldo F. Sciamanna (Univ. of California, Berkeley). *J. Phys. Chem.*, 65: 1286-91 (Aug. 1961). (UCRL-9363 (Rev.))

The radiolysis of biacetyl vapor studied at 25, 120, and 200° with pulsed electrons from a 4.2 Mev microwave linear accelerator. Effects of pressure, pulse rate, and total dose were studied. At room temperature the relative yields of methane and ethane were only slightly dependent on experimental parameters, but at higher pressures the relative yields were pressure dependent. A free radical mechanism is proposed to explain the formation of the major products and this is shown to account qualitatively for the experimental observations. (auth)

29248 RADIATION CHEMISTRY OF NEOPENTANE. Richard A. Holroyd (Mellon Inst., Pittsburgh). *J. Phys. Chem.*, 65: 1352-7 (Aug. 1961). (RRL-54)

The products of the radiolysis of liquid neopentane were examined in detail at several different dose rates and as a function of the concentration of isobutene. The major products from pure neopentane are those expected from reactions of hydrogen atoms and methyl, t-butyl and neopentyl radicals. The major unsaturate formed is isobutene. In addition there are unexpected products in the C_3 and C_4 region which result from the reaction of hydrogen atoms with isobutene. When large amounts of isobutene are present, radicals are also scavenged. A dose rate effect is observed in pure neopentane and is attributed mainly to the competition between methyl radicals abstracting hydrogen from neopentane and radical combination reactions, the latter being favored at high dose rates. (auth)

29249 THE RADIATION-INDUCED REACTION BETWEEN BENZENE AND IODINE. Albert T. Fellows and Robert H. Schuler (Brookhaven National Lab., Upton, N. Y.). *J. Phys. Chem.*, 65: 1451-3 (Aug. 1961).

A more detailed examination of the radiation chemistry of benzene-iodine solutions was undertaken in order to examine the suitability of iodine as a radical detector in aromatic systems. The changes which occurred in the absorption spectrum of a 4×10^{-3} M solution of iodine in benzene during and after a 5 microampere fast electron bombardment are illustrated. A darkening through shades of gray and dark green was observed. Upon further standing the absorption did not increase and was unaffected by light in the absence of air. After exposure of the sample to air the coloring faded very quickly in bright sunlight. The color of the aerated sample was reasonably stable when stored in the dark. The nature of the colored substance formed is unknown. A large number of Co^{60} gamma irradiations were also carried out at various iodine concentrations. (P.C.H.)

29250 GAMMA-IRRADIATION OF ISOPROPYL-BENZENE ADSORBED ON MICROPOROUS SILICA-ALUMINA. Robert R. Hentz (Socony Mobil Oil Co., Inc., Princeton, N. J.). *J. Phys. Chem.*, 65: 1470-1 (Aug. 1961).

Isopropylbenzene was irradiated with Co^{60} gamma rays in the presence of a microporous silica-alumina, and the heterogeneous system was studied at 36°C over a range of composition expressed in terms of the electron fraction, F, of isopropylbenzene from 0.0017 to 1.0. A table is given that shows the yields over a range of conditions from liquid at 36°C to gas at 400°C and at 1.0 atm. The benzene yield is increased relative to the yields of all other products in the heterogeneous system, and the yields for isopropyl-

benzene conversion and benzene formation are higher in the presence of the solid than in the pure liquid at the same temperature even though the radiation is absorbed overwhelmingly in the solid. This suggests the possibility that a solid may to some extent direct absorbed radiation energy into the reaction for which it is a thermal catalyst. Other points of interest are also discussed. (P.C.H.)

29251 GAMMA IRRADIATION OF FLUOROCARBON POLYMERS. Roland E. Florin and Leo A. Wall. *J. Research Natl. Bur. Standards*, 65A: 375-87 (July-Aug. 1961).

Several fluorocarbon polymers were irradiated with Co^{60} gamma radiation at doses up to 10^{22} ev/g. The polymers studied included polytetrafluoroethylene, polytrifluoroethylene, polychlorotrifluoroethylene, a copolymer of tetrafluoroethylene with hexafluoropropylene, and several rubbery vinylidene fluoride copolymers. G-values were measured for volatile products, for free radicals detected by electron spin resonances, and, in the case of polychlorotrifluoroethylene, for scissions. The course of degradation or crosslinking was followed by zero-strength-time and tensile-strength measurements. It was found that for polytetrafluoroethylene and its hexafluoropropylene copolymer the presence of air accelerated scission drastically. The mechanism of the radiation-induced changes is discussed in terms of free-radical intermediates. (auth)

29252 THE PREPARATION OF CARRIER-FREE SULFURIC ACID (S^{35} LABELLED). M. Kucharski and R. Plejewski (Inst. for Atomic Research, Polish Academy of Sciences, Warsaw). *Kernenergie*, 4: 445-8 (June 1961). (In German)

A method for the preparation of S^{35} in the form of sulfuric acid on an industrial scale was described. The nuclear reactor EWA was used as the neutron source for the irradiation. The sulfur is destined for medical and scientific purposes. It can be used as the starting material for the synthesis of various S^{35} -labeled compounds. (tr-auth)

29253 THE ENERGY OF ELECTRON-HOLE PAIR FORMATION BY X-RAYS IN PbO . F. Lappe (RCA Labs., Ltd., Zurich). *Phys. and Chem. Solids*, 20: 173-6 (Aug. 1961). (In English)

Single crystals of yellow PbO were grown and irradiated by $\text{CuK}\alpha$ radiation. By comparing the x-ray induced photocurrents with the light induced photocurrents the average energy necessary to produce an electron-hole pair in PbO by x-ray was determined to be 8 ev. (auth)

29254 ELECTRON SPIN RESONANCE OF IRRADIATED FERROELECTRIC TRI-GLYCINE SULFATE. R. Blinc, S. Detoni, I. Levstek, M. Pintar, S. Poberaj, and M. Schara (J. Stefan Inst., Ljubljana, Yugoslavia and Ljubljana Univ., Yugoslavia). *Phys. and Chem. Solids*, 20: 187-9 (Aug. 1961).

A preliminary analysis of the electron spin resonance spectra of ferroelectric triglycine sulfate single crystals, which were subjected to γ -ray damage indicated that the principal stable radical produced by γ -ray damage is $\text{NH}_3\dot{\text{C}}\text{H}-$; that the orientations of the radicals are fixed in the crystal lattice; that the approximate values of the H_{C} , the three H_{N} , and the N Fermi coupling constants are 21.0, 14.5 and 3.2 g respectively; and that the NH_3 group is rotating in the ferroelectric phase. (auth)

29255 ON THE DIELECTRIC LOSS AND THERMAL BLEACHING OF CALCITE IRRADIATED BY X-RAYS. K. V. Rao (Indian Inst. of Tech., Kharagpur, India). *Phys. and Chem. Solids*, 20: 193-6 (Aug. 1961). (In English)

The changes produced by x irradiation in the dielectric and optical properties of calcite crystals are reported. At

ordinary temperatures, the dielectric constant as well as the dielectric loss of the uncolored crystal remains practically unchanged in the frequency region of 10 kc/s-15 Mc/s. It was found that the temperature variation of its dielectric loss is represented by an equation $\tan \delta = A + B e^{-0.4/kT}$ where A and B are constants; this is attributed to the movement of vacancies in the crystal. On irradiation by x rays, calcite exhibits pronounced optical absorption in the ultraviolet region beyond 400 μ ; the dielectric loss of calcite also increases considerably on coloration. The thermoluminescence shows a very strong glow peak at 85°C with minor ones at higher temperatures. During thermal bleaching, the dielectric loss of the colored crystal shows a prominent maximum at 70 to 120°C and beyond 230°C, it varies in the same way as in the case of the uncolored crystal. The correspondence between the change in dielectric loss and the first glow peak is possibly due to thermal release of trapped electrons. The optical absorption disappears when the crystal is heated to 350°C and on cooling to room temperature, its dielectric loss returns to its original value before coloration. (auth)

29256 RADIATION INDUCED CHEMISORPTION OF OXYGEN ON CHROMIA. M. Nachman, I. Maxim, and T. Braun (Inst. of Atomic Physics, Bucharest). *Phys. and Chem. Solids*, 20: 307-14 (Aug. 1961). (In English)

The effect of nuclear radiation on the chemisorption of oxygen on Cr_2O_3 , $\text{Cr}_2\text{O}_3-\text{Al}_2\text{O}_3$ and $\text{Cr}_2\text{O}_3-\text{SnO}_2$ catalysts was studied. An iodometric method was used to measure the amount of chemisorbed oxygen; simultaneously the increase in the catalytic activity of the catalyst in the decomposition of H_2O_2 was determined. It was found that the radiation present within a nuclear reactor promotes the chemisorption of oxygen on chromia (either pure or supported on Al_2O_3 or SnO_2) at temperatures at which such a chemisorption does not normally occur. The radiochemisorption of oxygen on chromia increases with the degree of dispersion of chromia on Al_2O_3 or SnO_2 and is accompanied by an increased catalytic activity of this catalyst in the decomposition reaction of H_2O_2 . It seems that the radiochemisorption is largely due to the action of γ rays and fast neutrons on the gas. (auth)

29257 AN EFFECT OF IONIZING RADIATIONS ON THE HYDROGEN BONDS IN WOOL. Eugene Allen and Peter Alexander (St. Bartholomews Hospital, London and Inst. of Cancer Research, London). *Radiation Research*, 15: 390-9 (Sept. 1961).

Irradiation with 15-Mev electrons changes certain physical properties of wool fibers profoundly, even after doses of as little as 5×10^6 rads. Lithium bromide solutions disorientate the crystalline areas of wool which consist of polypeptide chains held together by hydrogen bonds. Irradiation increases the disorientation produced by lithium bromide and renders it irreversible. In sodium bisulfite solutions, wool contracts by breaking the disulfide bonds in the matrix in which the micelles are held. This effect is increased by irradiation, but the influence of radiation is less far-reaching than in the lithium bromide test. These radiation-induced changes can be stimulated, in part at least, by chemical treatments that break disulfide or peptide bonds. But the number of bonds that have to be broken is many times as great as the number that are destroyed by a dose of radiation that gives a comparable effect. It is concluded that the relevant changes produced by radiation reside in the hydrogen bonding of the micelles and that radiochemical changes involving covalent bonds are not principally responsible. The changes studied were essentially independent of moisture content of the wool fibers and of the presence of oxygen. (auth)

29258 MECHANISM OF INACTIVATION OF ENZYME PROTEINS BY ULTRAVIOLET LIGHT. A. D. McLaren and R. A. Luse (Univ. of California, Berkeley). *Science*, 134: 836-7 (Sept. 22, 1961).

Some quantum yields for the destruction of amino acids were determined. The inactivation of the enzymes chymotrypsin, lysozyme, ribonuclease, and trypsin by ultraviolet light can be accounted for quantitatively by summing the products of the probability that light is absorbed by a given amino acid residue, ϵ_1 , and the probability that absorbed light induces a chemical change, with a quantum efficiency ϕ_1 , in the residue. The principal residues involved are cystyl and tryptophanyl. Peptide bond rupture is not important. Analysis of inactivated enzymes verifies the assumption of the existence of several inactivation mechanisms. (auth)

29259 RADIATION-INDUCED REACTION OF CARBON DIOXIDE WITH ETHYLENE. C. E. Stoops and C. L. Furrow (Phillips Petroleum Co., Bartlesville, Okla.). *Science*, 134: 839-40 (Sept. 22, 1961).

The gamma irradiation of mixtures of carbon dioxide with ethylene yielded long-chain carboxylic acids. The $G(-\text{ethylene})$ values varied with reaction temperature from essentially zero at -78°C to 175 at 100°C . Under the same conditions, the substitution of free radical agents for radiation gave polyethylene. (auth)

29260 THERMOLUMINESCENCE OF KCl AND NaCl AFTER X AND UV IRRADIATION AT HELIUM TEMPERATURE. Fred Fischer (Universität, Göttingen, Ger.). *Z. Physik*, 163: 401-23 (1961). (In German)

Glow curves of luminescence are recorded in the range from 10°K to 300°K . One gets characteristic changes by prior annealing of the single crystals in O_2 or HCl . Also an increase of the lattice disorder causes new glow bands. In KCl a strong glow band always appears at 40°K after irradiating with x rays or ultraviolet light in the range of the exciton bands. It is ascribed to trapped excitons, which become mobile at that temperature. For x irradiated KCl the glow curve of luminescence is compared with the electrical glow bands and with the concentration change of known defects. The half width ΔT of all glow bands is found proportional to the temperature of the maximum: $\Delta T = (0.08 \pm 0.02)T_m$. (auth)

29261 THE CHEMICAL AND BIOLOGICAL ACTION OF RADIATIONS. VOLUME V. M. Haïssinsky, ed. I. MECHANISM OF THE RADIOLYSIS OF WATER BY GAMMA RAYS OR ELECTRONS. A. O. Allen. II. ACTION OF ALPHA RADIATION ON AQUEOUS SOLUTIONS. J. Pucheault. (In French). III. DIFFUSION KINETICS IN RADIATION CHEMISTRY. A. Kuppermann. IV. MASS SPECTROMETRY AND RADIATION CHEMISTRY. D. P. Stevenson. London, Academic Press Inc. and Paris, Masson et C^{ie}, Editeurs, 1961. \$8.00. 289p.

Four papers on the mechanism of the radiolysis of water by gamma rays or electrons, alpha radiation action on aqueous solutions, diffusion kinetics in radiation chemistry, and mass spectrometry and radiation chemistry are included in the volume. Separate abstracts have been prepared for each paper. (P.C.H.)

29262 MECHANISM OF THE RADIOLYSIS OF WATER BY GAMMA RAYS OR ELECTRONS. A. O. Allen (Brookhaven National Lab., Upton, N. Y.). p.11-30 of "The Chemical and Biological Action of Radiations. Volume V." London, Academic Press Inc. and Paris, Masson et C^{ie}, Editeurs, 1961.

In the absence of a firm theoretical basis, a review is given of the experimental data regarding the radiolysis of

water with reference to any apparent peculiarities in the kinetics which provide hints as to the nature of the radicals or the mechanism of their formation. An historical review is given along with the reaction kinetics in water radiolysis and the nature of hydrogen atoms in water. Future studies on the reaction rates of free radicals are discussed. (P.C.H.)

29263 ACTION OF ALPHA RADIATION ON AQUEOUS SOLUTIONS. Jacques Pucheault (Laboratoire Curie de l'Institut du Radium, Paris and Laboratoire de Synthese Atomique, Ivry, [France]). p.33-84 of "The Chemical and Biological Action of Radiations. Volume V." London, Academic Press Inc. and Paris, Masson et C^{ie}, Editeurs, 1961. (In French).

A topography of distribution of radiolytic products is postulated. Essentially, the existence, in the immediate neighborhood of the trajectories, of a zone of molecule-radical reactions, $\text{H}_2 + \text{OH}$, $\text{H}_2\text{O}_2 + \text{OH}$, and $\text{H}_2\text{O}_2 + \text{H}$, the importance of which should depend on the nature and concentration of the solute, is assumed. The hypothesis includes as a special case the proposal that the free radical HO_2 is formed within the trajectories of the alpha particles. Several difficulties presented by this theory are pointed out, and various suggestions for eliminating them are given. Oxidation of iron sulfate solutions, reduction of cerium sulfate solutions, study of the system $\text{V}^\text{V}/\text{V}^\text{IV}$, and the physics aspect of zones of heterogeneity including the extreme limits of the zones of the reactions (a), (b), and (c) are also discussed. (P.C.H.)

29264 DIFFUSION KINETICS IN RADIATION CHEMISTRY. Aron Kuppermann (Univ. of Illinois, Urbana). p.87-166 of "The Chemical and Biological Action of Radiations. Volume V." London, Academic Press Inc. and Paris, Masson et C^{ie}, Editeurs, 1961.

The general diffusion-kinetic model is formulated and discussed. The formulation is not restricted to the particular case of aqueous solutions. Several analytical and numerical treatments of one- and two-radical models are presented and criticized, and the onset and kinetics of dose rate effects are given. Comparison with experiments, which includes variation of yields with solute concentration and radiation quality, molecular yields and initial distributions, and formation of HO_2 in deaerated solutions, are also given. (P.C.H.)

29265 MASS SPECTROMETRY AND RADIATION CHEMISTRY. D. P. Stevenson and D. O. Schissler (Shell Development Co., Emeryville, Calif.). p.169-270 of "The Chemical and Biological Action of Radiations. Volume V." London, Academic Press Inc. and Paris, Masson et C^{ie}, Editeurs, 1961.

The strengths and limitations of mass spectroscopy are discussed as a source of basic radiation chemical knowledge. The subjects are: mass spectrometry and mass spectra, including semantics and scope and sample introduction and pumping considerations; ionization cross sections, including dependence of Q_1 on E_e and molecular constitution and structure and ionization at atmospheric pressure by high and heterogeneous energy electrons; appearance potentials and the energetics of ions and molecules, including threshold ionization efficiency curves, the appearance potentials from them, and the interpretation of and methods for determining the appearance potentials; mass spectra including quasi-equilibrium rate theory, the nature of $D(\epsilon)$, the relative magnitudes of the frequency terms $\Sigma_i T_i$, the Q - E theory and the appearance potentials of ions, and the effect of temperature on mass spectra; and ion-molecule and related reactions, including collision

frequency, experimental results, limitations of the mass spectrometer, collision induced dissociation reactions, and collision ion formation. Representative examples of reactions between ions and molecules that have been observed to occur in the ion sources of conventional mass spectrometers are summarized, and a bibliography of publications in which the observations are described and discussed is given. In addition, an appendix outlines methods for the determination of parameters from mass spectral measurements and instrument design data and also discusses the determination of the processes giving rise to nonintegral m/q ions in mass spectra and the origin of mass dependent discrimination. (P.C.H.)

29266 IMPROVEMENTS IN OR RELATING TO PROCESSES FOR PRODUCING COPOLYMERS. (to Houilleres du Bassin du Nord et du Pas de Calais). British Patent 872,537. July 12, 1961.

A process is described for producing copolymers from monomers by irradiation. The process consists of activating a basic polymer by means of an ionizing radiation, and reacting the irradiated polymer in succession with at least two monomers differing from one another, the amount of the monomer reacting first being lower than the amount which is sufficient to exhaust the activity given to the basic polymer. The monomer reacting first is different from the monomer from which the basic polymer is prepared. When the basic polymer is brought into contact with the monomers, an agent is applied having the function of an inhibitor with respect to the second monomer. This agent is destroyed at the end of the reaction for the fixation of the monomer. The basic polymer may be a polyethylene and the monomers may be acrylonitrile and styrene or vinyl chloride and ethylene. (N.W.R.)

29267 A METHOD OF POLYMERIZATION OF VINYL ACETATE. (to Kurashiki Rayon Kabushiki Kaisha). British Patent 876,660. Sept. 6, 1961.

A method of producing polyvinyl acetate is given wherein vinyl acetate is polymerized in solution in a water-miscible, water-containing organic solvent under high-energy ionizing radiation. The solvent may be hydrous methanol, hydrous ethanol, or hydrous acetic acid. The advantages of this method are that the polymerization rate is higher than in the anhydrous state, and that the polyvinyl acetate may be hydrolyzed to give polyvinyl alcohol of superior properties. (D.L.C.)

29268 GRAFT POLYMERIZATION USING IONIZING RADIATION AS THE GRAFT POLYMERIZATION INITIATOR. Adolphe Chapiro and Michel Magat (to Centre National de la Recherche Scientifique). Canadian Patent 620,826. May 23, 1961.

A method for graft polymerizing a monomer on a polymer by ionizing radiation is described which eliminates or suppresses homopolymerization of the monomer. In this method, the polymer-monomer system is contacted with a polymerization inhibitor which inhibits the monomer but not the polymer. This selective action is achieved by using an inhibitor which is more soluble or disperses more readily in the monomer phase than in the polymer phase. (D.L.C.)

Raw Materials and Feed Materials

29269 (GAT-389) ACID LEACHING OF ALUMINA FOR URANIUM RECOVERY. W. S. Fleshman and J. R. Davis (Goodyear Atomic Corp., Portsmouth, Ohio). Aug. 22, 1961. Contract AT(33-2)-1. 18p.

It was found that up to 99.9% uranium can be removed

from alumina efficiently and economically in geometrically safe equipment by continuous leaching with dilute nitric acid for about eight hours. Resulting solutions of uranyl nitrate require little adjustment for solvent extraction recovery operations. The small amount of fines present can be readily removed by settling. Normality of the residual free nitric acid in the solution is in the required range of about 0.5 to 1.0. Sufficient aluminum nitrate for fluoride complexing is provided by dissolution of a small amount of alumina. (auth)

29270 (NLCO-600(Rev.)(Del.)) SUMMARY TECHNICAL REPORT FOR THE PERIOD OCTOBER 1, 1955 TO DECEMBER 31, 1955, VOLUME I. John W. Simmons, ed. (National Lead Co. of Ohio, Cincinnati). Jan. 16, 1956. Decl. with Deletions Mar. 7, 1960. Contract AT(30-1)-1156. 123p.

Laboratory tests showed that there is a direct relationship between the sulfur content of Q-11 ore and its digestion reactivity. It was also shown that roasting the ore decreased this reactivity. Rum Jungle uranium concentrate was evaluated and results indicated that this material can be processed in the NLO Refinery. Pilot Plant extraction tests on South African ore showed that no difficulty should be experienced in processing this material. Process modifications in the 33.5% TBP flow sheet were required. The progress of chlorine through the HNO_3 concentrator and the ozonation system was studied. It was found that 41% of the ozone was consumed in the hot nitric acid, either by side reactions or by decomposition. Studies made in the hexafluoride reactor indicated that use of a cyclone-type premixer is a good method for injecting reactor feed gases. Copper was proved not to be a satisfactory material for the UF_6 reduction reactor. Tests were made of Port Hope UO_3 to determine its reactivity index. Reduction of UO_3 and hydrofluorination of powdered UO_2 were studied in the thermal balance. An apparatus was developed for measuring the temperature along the screw of a reduction reactor. Stainless steels showed much better resistance to corrosion than did high-nickel alloys in the reaction zone of UO_3 reduction reactors. It was determined that set time and tackiness of $\text{UO}_3\text{-H}_2\text{O}$ mixtures are functions of temperature and water content. Water addition to UF_6 seemed to improve derby yield and appearance when slag liners were used. A method for the elimination of secondary pipe in production ingots was demonstrated. Several types of refractories were evaluated in production furnaces. Special melting and casting techniques were used to insure homogeneity of uranium alloys and for the casting of uranium containers. A simplified process for the recovery of uranium from enriched scrap was developed. The phosphate method of recovering uranium from C-oxide was found to give a better grade product than the NH_4OH precipitation process. $\text{Al}(\text{OH})_3$ was found to be the most effective aluminum compound in inhibiting the corrosion of stainless steels by fluoride-containing dolomite digestion solutions. (auth)

29271 (NLCO-690(Del.)) SUMMARY TECHNICAL REPORT FOR THE PERIOD JULY 1, 1957 TO SEPTEMBER 30, 1957. John W. Simmons, ed. (National Lead Co. of Ohio, Cincinnati). Decl. with deletions Feb. 3, 1960. Contract AT(30-1)-1156. 108p.

The processing of thorium-bearing uranium concentrates by phosphate complexing was demonstrated and placed on a regular production basis. The effects of acid concentration and chloride concentration on the oxidation of chloride in an electrolytic flow cell were evaluated. A method for treating used solvent from the refinery was developed. Results indicated that cation carryover can be

reduced by using a modified solvent treatment system. Reactivity of orange oxide was increased by adding ammonia to the uranyl nitrate product, but not to the degree realized with sulfate addition. The oxidative characteristics of UO_2 and their relationship to the hydrofluorination characteristics were studied. The presence of lithium in orange oxide was observed to be more detrimental to subsequent hydrofluorination than either sodium or potassium. Rate data for the hydrofluorination reaction were obtained for two types of feed material with the gas phase containing various concentrations of HF and H_2O . The regeneration of waste KF solution for reuse in the KOH neutralization of HF off-gases was studied. Heat transfer data obtained during dehydration of UO_3 pellets in the moving bed reactor were evaluated and correlated. Studies showed the feasibility of using H_2SO_4 as a substitute for HCl for leaching uranium from hydrometallurgical system scrap feed. Equipment is being developed for producing uranium metal by the continuous reduction of uranium tetrafluoride with magnesium. Melts were cast from charges that consisted of one or two components of the usual remelt charge. Data were obtained on the effect of each component on the carbon and nitrogen levels in ingots and the percentage yield of good slugs. A satisfactory polarographic method was developed for the determination of iron in uranyl nitrate and uranium tetrafluoride. A spectrographic method which uses a mixed carrier material in the analysis of U_3O_8 improved the excitation of iron and nickel, resulting in improved analytical precisions for these two elements. (auth)

29272 (NP-10649) MONTHLY DEVELOPMENT REPORT [ON FEED MATERIALS], JULY 1961. (Eldorado Mining and Refining Ltd. Research and Development Div., Ottawa). 11p.

Data from atmospheric carbonate leach tests from mill samples are tabulated. Tests on electrolytic production of sodium amalgam and sulfuric acid were continued. Results are tabulated. Data from tests made on Beaverledge carbonate mill tailings to determine if the contained V mineral can be pre-concentrated by magnetic treatment are given. In other work, data on reduction of U_3O_8 with Al were obtained. (J.R.D.)

29273 (TID-4020(C-3)(Rev.1)) COMPILATION OF PRICES, CHARGES AND SPECIFICATIONS FOR CONVERSION OF U_3O_8 UNH AND UF_4 TO UF_6 . Code C-3, Revision No. 1. (Division of Industrial Participation, AEC). Sept. 1, 1961. 2p.

A summary is presented of AEC specifications, standard conversion losses, processing time for computation of use charge, and charges for conversion service and delivery point with respect to services performed by AEC in conversion of unirradiated U enriched in U^{235} as U_3O_8 , uranyl nitrate hexahydrate (UNH), and UF_4 to UF_6 . (J.R.D.)

29274 (TID-5231) URANIUM TECHNOLOGY. General Survey. J. E. Vance—L. G. Bassett, ed. (New York Operations Office, AEC) and J. C. Warner (Argonne National Lab., Ill.). 1951. Decl. July 1, 1960. 231p. (NNES-VII-2A)

A review is given the technological development that resulted in the transformation of uranium from the status of a chemical curiosity, produced at great cost and with uncertain purity, to that of a commercial commodity produced in large amounts at the demand of definite production schedules and in accordance with rigid specifications of chemical purity and physical form. Methods are given for the production of uranium beginning with ore concentration and followed by the production of crude intermediates (U_3O_8 and sodium diuranate) and the preparation of

pure compounds (UO_3 , UO_2 , UF_4 , and UF_6), from one of which UF_4 metal was produced by thermal reduction with magnesium. (N.W.R.)

29275 PRESENT SITUATION OF THE URANIUM ORE PROCESSING. A. P. Zefirov, B. N. Laskorin, and B. V. Nevskii. *Atomnaya Energ.*, 11: 153-69 (Aug. 1961). (In Russian)

The basic raw material of the uranium industry consists of low-grade, often complex ores, treatment of which requires large industrial establishments. The net manufacturing cost of the metal was considerably reduced during the years by the introduction of novel economical and automatized processes which had to adapt to the newly uncovered ores such as carbonate-bearing, clayey minerals, ores containing U together with Fe, V, Mo and other metals. U-bearing phosphates and coals required special methods. Mechanical beneficiation, separation processes, leaching and extraction methods have been developed. The mechanical methods include steps involving separation of the material according to its U content at partially automatized radiometric control stations followed by additional enrichment by sorting machines. Sulfites of Cu, Fe and of other metals may be removed by flotation before or after the leaching operation. The insoluble U salts of fatty acids is used for separation by froth flotation. Mechanical crushing operations assume a great importance for the preparation of the ores. While acid leaching is the most important chemical method, alkaline leaching is used more and more for the treatment of high-carbonate ores. In the Soviet Union special attention was given to oxidation during extraction. Other techniques used include sorption methods and solvent extraction from sulfuric or phosphoric acid solutions. Cost estimates and methods used by Western countries, especially U. S. and Canada, are described. (TTT)

29276 METALLURGY IN NUCLEAR POWER TECHNOLOGY. I. EXTRACTION AND FABRICATION OF URANIUM. J. C. Wright (College of Advanced Tech., Birmingham, England). *Metal Treatment and Drop Forging*, 27: 265-74 (July 1960).

The metallurgical processes of uranium are outlined from the extraction process up to the fabrication of the metal for use in nuclear power production. (N.W.R.)

29277 TREATMENT OF URANIUM ORES FOR RECOVERY OF THE URANIUM CONTENT THEREOF. Denis I. Legge and Maxwell Lipworth (to Anglo-Transvaal Consolidated Investment Co., Ltd.). *Canadian Patent* 621,307. May 30, 1961.

An improved ferric sulfate leach process is outlined for recovering uranium from ores. In this process, the uranium is dissolved from the ore by leaching with sulfuric acid containing ferric sulfate, which converts the uranium into the uranyl form; the pulp is filtered and divided into two streams; oxygen and sulfur dioxide are passed into one stream to produce sulfuric acid and ferric sulfate; and the treated stream is recirculated to the incoming ore. The other stream is diluted for uranium recovery by ion exchange. Heat exchange is provided between the cooled recycled filtrate and hot pulp. (D.L.C.)

Separation Processes

29278 (AERE-C/M-112) THE EXTRACTION OF ZIRCONIUM AND PLUTONIUM BY TRIBUTYL PHOSPHATE. W. H. Hardwick and F. Bedford (United Kingdom Atomic Energy Authority. Research Group. Atomic

Energy Research Establishment, Harwell, Berks, England). [nd]. 5p.

Experiments were carried out to compare the extraction of zirconium and plutonium by TBP from dissolver solution, 4 to 6N in nitric acid, and the relative efficiency of low (1 to 4N) acid stripping. It was found that the extraction of both plutonium and zirconium increased with acidity, the ratio of K_{Pu}/K_{Zr} being approximately constant at 17. In all stripping experiments, values of K_{Pu} and K_{Zr} were found to be very similar, indicating that low acid stripping would not effect an appreciable separation of the two elements. (auth)

29279 (AERE-R-3575) AN ANALYTICAL SCHEME FOR THE INDIVIDUAL SEPARATION OF ZIRCONIUM, CERIUM, NEODYMIUM, AND TRACES OF THORIUM FROM SOLUTIONS CONTAINING ALUMINIUM. C. G. Wallace (United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England). June 1961. 10p.

An analytical scheme is described for the individual separation of thorium, zirconium, cerium, and neodymium from solutions containing aluminum. Procedures are described for the determination of thorium α activity and for the determination of cerium and neodymium as oxalates and zirconium as mandelate. (auth)

29280 (CF-61-8-68) EUROCHEMIC ASSISTANCE PROGRAM. Progress Report July 1960-June 1961. R. J. Sloat and E. M. Shank (Oak Ridge National Lab., Tenn.). Aug. 31, 1961. 16p.

The Eurochemic organization was modified to include special contact groups for the various architect-engineers. The current plant design capacity is 350 kg/day of natural uranium in aluminum or magnesium cladding and 200 kg/day of slightly enriched uranium (5% max.) in stainless steel and Zircaloy cladding. The processing of higher enrichment uranium (20 to 90%) is being considered. The preproject design is essentially complete and projecting work was started by three of the eight architect-engineer firms. Placement of currently authorized buildings was frozen, the administration building was completed and occupied, and a material storage area was built. The processing flowsheet includes two dissolver systems, an essentially conventional Purex solvent extraction system except for the final plutonium cycle, conventional waste concentration and acid recovery, and two solvent recovery systems. The main process building is 263 ft long, 89 ft wide, and 90 ft high, outside dimensions. Process research includes studies on laboratory-scale dissolution, mixer-settlers with low-activity feeds, TLA extraction for the final plutonium cycle, and silica gel for the uranium tail-end. Pilot plant-scale studies include flooding tests in the HA and HC columns, evaporator control, long-range airlift stability tests, bottom interface control devices, density measuring, and air pulsing. An article, "Aspects of Eurochemic Reprocessing Facility," by T. J. Barendregt, Technical Director, Eurochemic, is included. (auth)

29281 (HW-60278) NITROUS ACID BEHAVIOR IN PUREX SYSTEMS. L. L. Burger and M. D. Money (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 1, 1959. 21p.

A semiquantitative discussion is given on the formation, behavior, and decomposition of small (10^{-5} M to 10^{-2} M) concentrations of nitrous acid in nitric acid-tributyl phosphate systems. It is shown that nitrous acid is more stable in TBP than in an acid-aqueous solution. However, a typical plant solvent may consume nitrous acid through the diluent reactions faster than the normal decomposition

rate of HNO_2 . Autocatalytic reactions involving nitric acid which would raise the concentration of nitrous acid are not observed with Purex solvent below 50°C and in contact with nitric acid less than 10 M. These temperature and concentration limits may vary greatly depending on the diluent used with the TBP. Radiolysis produces nitrous acid from both aqueous and organic solutions of nitrates. An equilibrium value is reached which varies with composition but for acid solutions is less than 0.01 M HNO_2 . Equilibrium requires an energy absorption of from 50 to 200 watt hours per liter. Highly nitrated solvent may release nitrous acid on exposure to ultraviolet light. The extraction of nitrous acid by TBP is through hydrogen bonding to the phosphoryl oxygen. The 1:1 complex formed is of lower stability than the corresponding nitric acid complex but is more soluble in the organic phase. Infrared absorption curves are obtained for several TBP complexes involving nitrogen compounds. Several variables involved in the colorimetric analysis of nitrous acid are examined. (N.W.R.)

29282 (HW-70084) PROTOTYPE HOOD FOR DISSOLUTION OF PLUTONIUM SKULLS, PLUTONIUM METAL, AND FOR LEACHING OF INCINERATOR ASH. L. E. Bruns and C. W. Nilsen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 28, 1961. 14p.

Discussions are given of two processes, ammonium bifluoride-plutonium(IV) oxide fusion and recirculating continuous dissolver, for the recovery of plutonium(IV) oxide from burnt skulls. Schematic diagrams are included of the flowsheets for the processes. (B.O.G.)

29283 (IDO-14523) LABORATORY STUDIES FOR HTRE FUEL REPROCESSING. R. D. Cannon, B. E. Paige, K. L. Rohde, and M. W. Roberts, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). June 23, 1961. Contract AT(10-1)-205. 81p.

Uranium may be recovered from Heat Transfer Reactor Experiment nichrome fuels by a process involving: dissolution of fuel in mixed nitric and hydrochloric acids, removal of chloride from dissolution product by volatilization, and extraction of uranium from the chloride-free product into dilute tributyl phosphate. Laboratory studies served to define a batch process, furnished alternative operations, and provide data required for full-scale development. (auth)

29284 (IDO-14557) REMOTE DISSOLUTION AND ANALYTICAL PROGRAM FOR IRRADIATED THORIUM. G. A. Huff, I. L. Doggett, R. D. Fletcher, and M. E. Jacobson (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 14, 1961. Contract AT(10-1)-205. 13p.

A remote dissolution and analytical program for irradiated thorium is given. The aluminum jacket on the slug was dissolved with 6M nitric acid and 0.005M mercuric nitrate. After a water wash, the thorium dissolution was accomplished with concentrated nitric acid made 0.04M in hydrofluoric acid. Weighing, dissolving, and sampling were done remotely in the multicurie cell at the Idaho Chemical Processing Plant. Handling techniques for weighing and dissolving the slugs are described. Transferring and sampling apparatus as well as sampling techniques for the dissolved material are discussed. Analytical data obtained are tabulated. Abstracts of analytical methods for uranium concentration and isotope ratio, aluminum, thorium, cesium, and cerium are given. (auth)

29285 (IS-334) MASS TRANSFER COEFFICIENTS AND INTERFACIAL AREA IN A ONE STAGE PULSE

COLUMN. Alvin Eugene Konopik and Lawrence Burkert (Ames Lab., Ames, Iowa). Nov. 1960. 66p.
 Over-all mass transfer coefficients were determined dependently of the interfacial area by considering the operation of the pulse column to be a stage-wise process. The calculated coefficients describe only the operation of the pulse column for the free rise of organic droplets through a stage, since in the downstroke the aqueous phase passes through the organic phase in the form of rivulets preferentially wetting the plates. The driving force for transfer was based on the aqueous phase concentrations. The mass transfer coefficient was found to increase when the interfacial tension was reduced. Two factors appear to affect the mass transfer coefficient as the pulse frequency is changed and are: a) recycle or backmixing which tends to decrease the coefficient through a reduction of nitric acid in both phases and thereby increases the interfacial tension, and b) turbulence which enhances the coefficient by reducing the continuous film resistance. The first is important at or near the lower flooding limit, but the latter is the controlling factor at higher frequencies. (D.L.C.)

29286 (ORNL-TM-7) PILOT PLANT SHUTDOWN AND Pu-Al PROCESSING. J. C. Bresee (Oak Ridge National Lab., Tenn.). Sept. 25, 1961. Contract W-7405-Eng-26. 10p.

The large aqueous pilot plant facilities at ORNL were cleaned and are being put in standby condition. Experience was gained during the year as anion exchange was used to recover more than one kg of plutonium left in the exploded evaporator system. This experience is being applied to a new recovery program just beginning in cell 1 of Building 4507. (auth)

29287 (TID-13423) FRACTIONATION OF FISSION ELEMENTS BY ELECTRODIALYSIS. G. J. Bub, J. D. Vie, and W. H. Webb (Missouri School of Mines and Metallurgy, Rolla). [1961]. 17p.

An electrodialysis process, employing ion exchange membranes, is developed for separating and recovering Cs-Ba¹³⁷, Zr-Nb⁹⁵, Ce-Pr¹⁴⁴, Sr-Y⁹⁰, and Pm¹⁴⁷ from fission product waste solutions. Both a three and a seven cell electrodialysis unit are used for the separation process. Separation is not as complete with the seven cell unit as with the three cell unit, however, better separation can be expected by increasing the current density. The studies were performed on nitric, oxalic, and hydrofluoric acids in the three cell unit and nitric acid and ammonium acid fluoride in the seven cell unit. (N.W.R.)

29288 (AEC-tr-4805) STUDIES ON SOLVENT EXTRACTION OF INORGANIC SALTS. 4. DECOMPOSITION OF EXTRACTED NITRIC ACID ON THE EXTRACTION OF URANYL NITRATE BY TBP (TRIBUTYL PHOSPHATE). Taiichi Sato and Totaro Goto. Translated for Savannah River Plant, Aiken, S. C. from Kogyo Kagaku Zasshi, 1586-7(1960). 6p.

Uranyl nitrate was extracted from aqueous solution acidified with nitric acid by means of a TBP solvent of various concentrations, using kerosene as a diluent. After completion of the extraction, the TBP phase was separated from the aqueous solution phase and allowed to stand for a predetermined period, after which the state of decomposition of the nitric acid in the solvent phase was investigated. The results indicate that the nitric acid in the TBP phase gradually decomposes during standing and reaches a state of substantial equilibrium in 30 to 60 days. This decomposition is the more marked, the higher the nitric acid concentration in the TBP phase, and the lower the TBP

concentration there. The influence of the uranyl nitrate present was also investigated. It was learned that the decomposition of nitric acid is more rapid, the greater the quantity of uranyl nitrate present. (auth)

29289 (NP-tr-741) USE OF PHENYLARSONIC ACID TO SEPARATE NEPTUNIUM AND PLUTONIUM. I. E. Starik, A. P. Ratner, M. A. Pasvik, and F. L. Ginzburg. Translated by B. C. L. Salman for U.K.A.E.A., Atomic Energy Research Establishment, Harwell, Berks, Eng. from Radiokhimiya, 1: 545-7(1959). 8p.

A technique is described for separating Np from Pu. The Np, as Np(IV), is coprecipitated with Zr phenylarsonate, using phenylarsonic acid as the precipitating agent. Under these conditions, the Pu is reduced to Pu(III), and quantitative separation may be obtained. (T.F.H.)

29290 SOLVENT EXTRACTION OF INORGANIC NITRATES WITH DIPHOSPHONATE ESTER. I. ZIRCONIUM, YTTRIUM AND LANTHANIDE NITRATES. Hideo Saisho (Mitsubishi Atomic Power Industries, Inc., Saitama, Japan). Bull. Chem. Soc. Japan, 34: 859-61 (June 1961). (In English)

The extractability of Zr, Y, Ce, Pm, Eu, and Lu was studied on the system between tetra-n-butyl ethylene-diphosphonate (TBEDP)-kerosene and various nitric acid concentrations. The results obtained are plotted with results for extraction with TBP from nitric acid for comparison. The distribution ratios, which can increase when other nitrates are added to nitric acid, suggest that the extraction of zirconium by TBEDP depends on the nitrate ion concentration to some extent. The results also indicate that zirconium is extracted more readily from nitric acid solution containing aluminum nitrate than from pure nitric acid solution of the same total nitrate ion concentration. (P.C.H.)

29291 PILOT PLANT FOR EXTRACTION OF CESIUM-137. J. Fradin. Bull. inform. sci. et tech. (Paris), No. 51, 46-9(May 1961). (In French)

The pilot plant for Cs¹³⁷ extraction verified the chemical method developed in the laboratory. It served for determining the value of the different parts of the chemical apparatus and the control apparatus, and for extracting a sufficient quantity of Cs¹³⁷ to determine the fabrication technique for high activity dry sources. The operation during the first seven months of service is summarized. The performance of the remote-controlled installation for manufacture of the dry sources is described. (J.S.R.)

29292 SAFETY ASSESSMENTS IN THE NUCLEAR INDUSTRY. PART I. A. Quinton (United Kingdom Atomic Energy Authority, Risley, Eng.). Chem. & Process Eng., 42: 402-4(Sept. 1961).

Recommendations and regulations are made regarding safety assessments necessary in the selection of a site for a radiochemical processing plant. It is pointed out that site selection is affected by the position of existing facilities of particular importance to radioactive material processing; in addition there is also a need to ensure that the introduction of a new process does not produce an unacceptable hazard to surrounding buildings. A discussion is also presented concerning building position on the site and building safety features. (N.W.R.)

29293 THE SEPARATION OF INDIUM FROM ZINC AND ACCOMPANYING ELEMENTS BY EXTRACTION WITH ALKYLPHOSPHORIC ACIDS. I. S. Levin and T. V. Zabolotskii (Chemical-Metallurgy Inst. and Inst. of Inorganic Chemistry, Siberian Branch, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 139: 158-9(July 1, 1961). (In Russian)

It was shown that a 20% 2-ethylhexylphosphoric acid solution in kerosene extracts indium completely from sulfuric, perchloric, nitric, hydrofluoric, oxalic and formic acid solutions over a wide interval of concentrations. Indium can be back-extracted with 6 to 9 *N* HCl. With an initial concentration of In of 4.2 g/l, a concentrate of 120 to 130 g/l of In in HCl can be obtained by using this process. Zn, Cd, Cu, Co, Ni and Fe²⁺ have distribution coefficients of 10⁻² to 10⁻³ on extracting In from 10 *M* H₂SO₄ solution. Elements which form strong anion fluoride complexes are not extracted from HF solutions. In can be separated from Fe³⁺, Al, Ga, U, Zr, Sc and Ti. Large amounts of Fe³⁺ (>10 g/l) interfere with the extraction of In. (TTT)

29294 FRACTIONAL EXTRACTION OF PLUTONIUM AND URANIUM WITH TRI-N-BUTYL PHOSPHATE.

Tomitaro Ishimori, Kenju Watanabe, and Takeo Fujino (Japan Atomic Energy Research Inst., Tokyo). *J. At. Energy Soc. Japan*, 3: 507-12 (July 1961). (In English)

Uranium and plutonium were separated by a continuous fractional extraction method using two small pulse columns. The extraction of uranium was carried out with 20% TBP in kerosene from a 0.5 *N* nitric acid solution. Under such conditions uranium can be extracted with the organic solution, whereas plutonium remains in the aqueous solution. After removing the main bulk of uranium, the acidity of the aqueous solution was raised and plutonium was extracted with 20 or 40% TBP in kerosene. About 400 ml of the extracting agent was generally required for extracting uranium from 25 to 45 ml of the 0.2 ~ 1.26 *M* irradiated uranium solutions, and an additional 400 ml of TBP solution was necessary for extracting plutonium. The behavior of fission products possibly contaminating the uranium or plutonium fraction was also studied. (auth)

29295 THORIUM EXTRACTION BY DI-N-DECYLAMINE SULFATE IN BENZENE. W. J. McDowell and Kenneth A. Allen (Oak Ridge National Lab., Tenn.). *J. Phys. Chem.*, 65: 1358-61 (Aug. 1961)

The extraction of thorium from acidic sulfate aqueous systems by di-n-decylamine sulfate in benzene is inversely dependent on sulfuric acid activity and sulfate ion concentration. At low thorium levels, thorium distribution coefficients are independent of the total thorium concentration, and at high thorium levels the organic thorium molarity levels off at a value corresponding to $n = 6 \pm 1$ equivalents of amine sulfate per thorium sulfate. This approximate complex composition was confirmed by measurements of the acid transfers accompanying thorium extraction, according to the equilibrium $n\text{RH}_2\text{SO}_4 + (n/2)(1-x)\text{R}_2\text{H}_2\text{SO}_4 + \text{Th}(\text{SO}_4)_2 = \text{R}_n\text{H}_n\text{Th}(\text{SO}_4)_{2+n/2} + nx/2\text{H}_2\text{SO}_4$, where $\text{R} = (\text{C}_{10}\text{H}_{21})_2\text{NH}$ and $x = [\text{RH}_2\text{SO}_4]/([\text{RH}_2\text{SO}_4] + 2[\text{R}_2\text{H}_2\text{SO}_4])$. Measurements of the thorium distributions as a function of aqueous sulfuric acid activity, at constant sulfate ion molarity, permitted computation of an equilibrium constant for this reaction, and in addition provided a simultaneous, independent evaluation of n which was in good agreement with the results from extraction isotherm analysis and acid transfer. At low aqueous ionic strength, the thorium extrac-

tion coefficient variation with amine sulfate concentration was anomalously dependent on the mode of equilibration. The coefficients observed with slow stirring were significantly higher than with vigorous agitation. (auth)

29296 PAPER CHROMATOGRAPHIC SEPARATION OF ZIRCONIUM AND THORIUM. V. V. Balakrishnamurthy (Andhra Univ., Waltair, India). *J. Sci. Ind. Research (India)*, 20B: 453-4 (1961). (In English)

Satisfactory chromatographic separation of zirconium and thorium was achieved employing a solution of thiocyanic acid in isobutyl alcohol-water-pyridine (85:10:5) mixture as solvent. The R_f values for each element obtained by ascending and circular paper chromatographic techniques are reported. (auth)

29297 IMPROVEMENTS IN OR RELATING TO COLUMNS HANDLING COUNTERFLOWING LIQUID AND GAS PHASES. Peter Thomas Nettley (to United Kingdom Atomic Energy Authority). British Patent 876,712. Sept. 6, 1961.

A simplified technique for connecting together a pair of countercurrent columns arranged side by side using only a single feed, product, and waste system for the two columns is described. The system consists of a pair of countercurrent columns A and B arranged side by side and connected together by a pair of pipes. The first pipe is connected from the base of column A to an intermediate point along the length of column B. The second pipe is connected from the top of column B to an intermediate point along the length of column A. The pipe offering a greater impedance to vapor flow has a control valve providing a restriction in the pipe. The other pipe is unrestricted. (N.W.R.)

29298 PROCESS AND APPARATUS FOR THE SEPARATION OF SUBSTANCES BY VAPORIZATION. Léon Jacqué and Pierre Dumez (to Compagnie de Produits Chimiques et Électrométallurgiques). Canadian Patent 621,627. June 6, 1961.

A process is outlined for separating liquid or sublimable solid mixtures by fractional vaporization, and an apparatus is described for carrying out the process. In the process, a temperature gradient is established in a column of the mixture and moved upward in the direction of vapor flow. A carrier gas may be used to entrain the evolved vapors. Examples of the process are given in which ZrBr₄ containing 2% HfBr₄ and ZrCl₄ containing 1% HfCl₄ are separated. (D.L.C.)

29299 PROCESS FOR THE REDUCTION OF PLUTONIUM. Richard Wagner (to Commissariat à l'Énergie Atomique). Canadian Patent 626,591. Aug. 29, 1961.

In a known process for separating Pu from irradiated U, the mixture is dissolved in HNO₃, Pu(IV) and U(VI) nitrates are extracted by tributyl phosphate, and Pu(IV) is reduced to Pu(III) prior to back extraction with an aqueous solution. The reducing agent commonly used either is too slow (hydrazine or hydroxylamine) or results in the addition of Fe to Pu (ferrous compounds). These disadvantages can be avoided by using ascorbic acid, which effects rapid reduction of Pu(IV) even in the presence of HNO₃. (D.L.C.)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

29300 (AERE-R-3762) AN ARGON PURIFIER FOR A METALLURGICAL LABORATORY. R. F. Clayton and R. H. Phillips (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1961. 11p.

Design and operation are described of a plant which uses the hot calcium method to purify industrial argon. Argon containing less than 50 ppm nitrogen and 2 ppm oxygen is produced at a rate of 50 ft³ (S.T.P.)/hr, at pressures up to 150 psig. (auth)

29301 (AFSWC-TR-61-40) THEORETICAL STUDY OF BURST INDUCED TRANSIENT RADIATION EFFECTS IN BASIC ELECTRONIC CIRCUITS. Final Report. J. E. Bell and K. R. Walker (Hughes Aircraft Co., Culver City, Calif.). May 15, 1961. Contract AF29(601)-2538. 280p.

Work has shown an analog computer technique to be a powerful tool for the theoretical investigation of transient radiation effects on electronic circuits. Four normally linear amplifier circuits were investigated with respect to d-c and signal-level change, recovery time and phase shift. The computer program included limits to indicate non-linear circuit response caused by radiation. A semiconductor diode detector and two semiconductor bistable multivibrators were studied. The detector and bistable circuits were investigated using curve-follower techniques to simulate the semiconductor characteristics. The responses were analyzed for indications of d-c and signal-level changes, recovery time, and abnormal switching. (auth)

29302 (APEX-615) INVESTIGATION OF A CORRUGATED SHELL AS AN ELASTIC SUPPORT OF A BUNDLE OF RODS. J. H. Meier (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Apr. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 56p.

A study is made of suspension methods and their efficiency for a cylinder of rod bundles with non-uniform diametral expansion. Shells, springs, and corrugated shells are considered. (D.L.C.)

29303 (APEX-650) REPORT ON AIR FLOW TESTS OF A NARROW COLLECTOR PASSAGE WITH EIGHT TRANSVERSE FEEDER SLOTS (APPLICABLE TO 140E1 FORWARD SHIELD DESIGN STUDIES). R. W. Bell (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Feb. 21, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 21p.

Previous analytical studies have indicated that a constant area collector passage with transverse feeder slots will, if the collector passage is narrow, suffer severe momentum losses in axial pressure distribution. These studies also predicted that the losses can be minimized by stepping the width of the collector at each feeder exit, and by turning the feeder exit parallel to the collector passage. These effects are verified by a study of a simplified design employing eight transverse slots of uniform slot width, separated by slabs of uniform thickness. (auth)

29304 (CF-61-7-92) RING-JOINT SPRING-CLAMP DISCONNECT. P. P. Holz (Oak Ridge National Lab., Tenn.). July 14, 1961. Contract W-7405-Eng-26. 17p.

The Molten Salt Reactor Program requires simple, leak-detectable, radiation-resistant joints. The extreme re-

quirements call for pressures up to 250 psi and temperatures to 1200°F. Leak rate objectives for the mechanical joints are less than 1×10^{-6} atm. cc/sec (30 cc/year) as tested by a helium mass spectrometer. Two integral ring-joint spring-clamp flange sets were designed, built and tested for coupling $\frac{1}{2}$ and $1\frac{1}{2}$ -in. pipe, respectively. Final inner (system to buffer) seal leak rates with the $\frac{1}{2}$ -in. unit following eight assemblies and a total of 1020 thermal cycles between 100°F and 1200 to 1500°F were observed to be 2.22×10^{-7} atm. cc/sec at room temperature, and 5.7×10^{-8} atm. cc/sec at 1500°F. Outer (buffer to atmosphere) seal rates varied between 8.75×10^{-6} and 1.86×10^{-7} . Following 14 assemblies and 69 steam cycles up to 400°F with the $1\frac{1}{2}$ -in. unit, no detectable readings above background were observed in a helium mass spectrometer test on both inner and outer seals, assuring a seal tightness in excess of 1.3×10^{-8} atm. cc/sec. (auth)

29305 (CREL-951) A SOLID-STATE TYPEWRITER AND TAPE-PUNCH CONTROL UNIT. L. B. Robinson and J. Leng (Atomic Energy of Canada Ltd., Chalk River, Ont.). May 1961. 51p. (AECL-1261)

A recording unit is described which accepts binary-coded input information and stores it using a typewriter and/or a paper-tape punch. Since all the necessary electrical switching is done using solid-state diodes and transistors, the output speed is limited only by the mechanical operation of the recording devices used and electrical interference is eliminated since the rate of change of currents is low and controlled. Operation of the equipment is explained for both 10 and 60 digit per second output devices. (auth)

29306 (DLCS-3330201) 1A HEAT EXCHANGER LEAK TEST. CORE I, SEED 2. Test Evaluation. Section 2. (Duquesne Light Co., Shippingport, Penna.). First issue, July 24, 1961. 10p.

An investigation was conducted to determine which tubes of the 1A loop heat exchanger are leaking. Air pressure and probing tests are inconclusive and cannot be used to verify chemical sampling. (J.R.D.)

29307 (DP-611) LEAKAGE OF WATER FROM GASKETED JOINTS PROPOSED FOR THE HWCTR-PART II AND PUMP MECHANICAL SEAL VAPOR LEAKAGE. Frederick C. Apple (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Aug. 1961. Contract AT(07-2)-1. 26p.

The average leakage rate was less than 0.3 pound per year per linear inch of gasket when mockups of typical joints proposed for the reactor vessel and the isolated coolant loops of the HWCTR were subjected to temperature and pressure cycling. The joints, which were exposed to deionized light water, were cycled about 100 times from 70°C and atmospheric pressure to 250°C and pressures of 1500 psig for the vessel joints and 750 psig for the joints designed for the isolated coolant loops. The average leakage of water vapor from a pump mechanical seal was less than 1.4 lb/yr during a five-month period. The pump circulated deionized water at 260°C and 850 psig. (auth)

29308 (HW-53004(De1.)) AN EFFICIENT METHOD FOR RADIATION AND VENTILATION CONTROL OF CONTAMINATION ENCLOSURES. Process Technology Information Report. H. A. Moulthrop (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 9, 1957. 14p.

An efficient method for shielding and ventilation of contamination enclosures containing process equipment for radioactive materials is described. A spacious, low-density, easily accessible, unshielded contamination enclosure is used for this method because it permits improved flexibility not only for process control and changes, but also for maintenance since it is adaptable for either unit replacement or in-line repair. By using this type of localized shielding around the individual process equipment units, a secondary internal ventilation control system can be used which provides control of radioactive particles which would otherwise escape from the unsealed equipment shields. A typical structure (hood) employing this long-range concept of radiation exposure control is shown in perspective along with a method for changing the filters in the ventilation system. This localized shielding is adaptable to the use of disposable liners. (N.W.R.)

29309 (HW-63788) KAPL-120-8A TEST ASSEMBLY THERMOCOUPLE FAILURE. F. E. Dearing (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 5, 1960. 12p.

The circumstances surrounding the failure of stainless steel-sheathed iron-constantan thermocouples during a fuel assembly test in the KAPL-120 loop are reported. It is concluded that the thermocouple sheathing was defective when received from the vendor. (D.L.C.)

29310 (K-1131(Del.)) STRESS ANALYSIS AND CYCLE LIFE TEST OF A 72-INCH DIAMETER ALUMINUM EXPANSION JOINT. L. C. Hare and H. H. Hall (Oak Ridge Gaseous Diffusion Plant, Tenn.). May 28, 1954. Contract W-7405-eng-26. 32p.

An aluminum expansion joint was tested to destruction by cycling through plus and minus $\frac{1}{4}$ -in. movement while under internal pressure. Strain gage measurements were taken. The unit failed at 5850 cycles of movement. (auth)

29311 (KAPL-2114) A FORMAL PROCEDURE FOR RAPID OPTIMIZATION OF DESIGN PERFORMANCE. D. C. Sherman (Knolls Atomic Power Lab., Schenectady, N. Y.). Mar. 22, 1961. Contract W-31-109-Eng-52. 56p.

A problem encountered in engineering design is discussed for determining values for a set of design variables that will mutually optimize a set of responses specifying the design performance. The mathematical statement of the problem is: simultaneously maximize selected responses from the set $f_h(x_1, x_2, \dots, x_m)$ subject to the conditions that all responses in the set satisfy given constraints of the form $f_h(x_1, x_2, \dots, x_m) \geq C_h$ and, or $f_h(x_1, x_2, \dots, x_m) = C_h$, and the accessible range of the variables is restricted by $a_j \leq x_j \leq b_j$ where (x_1, x_2, \dots, x_m) are m independent design variables, C_h is the limit imposed on the h^{th} response, and a_j and b_j are lower and upper bounds imposed upon the j^{th} design variable by either physical limitations or other considerations. This statement is similar and essentially equivalent to the usual statement of the mathematical problem of nonlinear programming. The outlined systematic procedure reduces to a minimum the number of design variations which must be analyzed to optimize design performance. The design performance and the performance gradient, evaluated at some initial point in variable space, define a path along which the predicted improvement in design performance is most desirable. The best point on this path is determined by the evaluation of performance at selected points. If further improvement in performance is desired, the best point on the path is used as a new initial point and the procedure repeated until additional improvement is either unobtainable or not required. (auth)

29312 (LAMS-2598) OPERATING CHARACTERISTICS OF A CESIUM DIODE UTILIZING FISSION HEATING OF THE EMITTER. Walter Reichelt, E. Salmi, G. Grover, and W. Schafer (Los Alamos Scientific Lab., N. Mex.). June 1961. Contract W-7405-eng-36. 14p.

Short circuit currents, open circuit voltages, power curves, and general operating characteristics are given for a series of cesium plasma diode experiments which utilize fission heat to obtain high emitter temperatures (to 2200°K). These experiments were performed in the Omega West Reactor facility at the Los Alamos Scientific Laboratory. The experimental configuration of the plasma cell was cylindrical, the emitter a cylinder of $(\text{UC})_{0.3}(\text{ZrC})_{0.7}$ with an area of 4.7 cm² and the emitter collector spacing 0.040 in. Maximum short circuit current, open circuit voltage, and power output were 130 amperes, 4.2 volts, and 85 watts, respectively. Where operating pin temperature was measured, the data corresponded favorably with the electrically heated plasma cell data. (auth)

29313 (NAA-SR-Memo-6171) SPRING-MASS-DAMPED SYSTEM EXPONENTIAL RESPONSE. R. N. Cordy (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). June 27, 1961. 16p.

The second-order equation describing spring-mass-damped systems is solved for exponential forcing functions. The results, presented as amplitude and time delay errors, are plotted for large ranges of natural frequency, damping, and exponential period. (auth)

29314 (NAA-SR-Memo-6539) DESIGN OF CYLINDRICAL EDDY-CURRENT BRAKE. R. S. Baker (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). June 26, 1961. 16p.

A preliminary design of an eddy-current throttling device to be used in conjunction with a centrifugal pump in the Sodium Reactor Experiment is described. The brake will operate at a sodium temperature of 478°F. It will be capable of throttling the sodium flow in 166-gpm increments over the range of 166 to 1655 gpm against a driving head of 210 ft. It will require 15 amps of direct current at 134 volts. The brake consists of a cylindrical steel shell with grooves for two field coils. The arrangement is concentric with a pipe carrying the molten sodium. The total weight is 2400 lb. (auth)

29315 (NP-10547) EVALUATION-DEVELOPMENT OF MIL-C-14157 CAPACITORS FOR NUCLEAR RADIATION ENVIRONMENT. Scientific Report No. 8. E. R. Pfaff (Admiral Corp., Chicago). July 1961. Contract Nobsr-77612. 78p.

Test results from irradiation of capacitors are reported. Half of the reconstituted mica capacitors survived 1000 hrs of gamma irradiation with little change in the capacitance or dissipation factors. Others which survived similarly were the units with Samica dielectric film impregnated with either C-oil resin or monoisopropylbiphenyl fluid. (J.R.D.)

29316 (SCTM-11-61-81) A PROPOSED METHOD FOR ESTABLISHING DIMENSIONS AND TOLERANCES. E. W. Kenderdine (Sandia Corp., Albuquerque, N. Mex.). June 1961. 61p.

A dimensioning method is proposed in which two basic types of tolerances, each of which is divided into two groups, are used. These four types of tolerances replace 17 types of tolerances in current use. The method uses a plus/minus tolerancing system; the details of this system are defined and interpreted. (auth)

29317 (SCTM-37-61(73)) METHODS AND CONCEPTS IN ACOUSTICAL ENVIRONMENTAL TESTING. R. I. But-

ler (Sandia Corp., Albuquerque, N. Mex.). Feb. 1961. 15p.

Basic methods and concepts for producing, measuring, and interpreting high-intensity sound fields for the acoustical evaluation of components and vehicles powered by high-thrust jet and rocket engines are presented. (B.O.G.)

29318 (SCTM-115-61-(25)) THE AUTOMATION OF PRODUCT TESTERS. C. C. Klutts (Sandia Corp., Albuquerque, N. Mex.). Aug. 1961. [Contract AT(29-1)-789]. 24p.

Product Testers (PT's) are tools used to determine whether components are acceptable for their intended use. A PT may be manually operated, semiautomatic, or completely automatic. Some important considerations in determining the optimum degree of automation for a specific PT are discussed. (auth)

29319 (TAM-161) THE STRESS CONCENTRATION AT RADIAL OUTLETS IN SPHERICAL PRESSURE VESSELS (THE AREA METHOD). N. C. Lind (Illinois Univ., Urbana). Mar. 1960. Contract NObs 611-077. 30p.

An outline is given of a method to determine the elastic stress-concentration factor of axial outlets from spherical and other symmetrical vessels subjected to internal pressure. The computed values of the stress-concentration factor are compared with the results of photoelastic tests, showing good agreement, ordinarily within the limits of experimental accuracy. (auth)

29320 (TID-13649) PROGRESS REPORT [ON SAMPLING UNITS] FOR JULY AND AUGUST, 1961. (General Mills, Inc., Minneapolis). Contract AT(11-1)-401. 15p.

Development and testing of balloon-borne sampling units for high-altitude use are described. Results are given for ground tests of the adsorption pump and for in-flight tests of the Direct Flow Sampler. (D.L.C.)

29321 (TID-13651) PERTURBATION SOLUTION OF A CLASS OF AXISYMMETRICAL SHELLS SUBJECTED TO A UNIFORM PRESSURE. Annual Report. K. N. Tong (Syracuse Univ., N. Y. Research Inst.). July 1961. For Oak Ridge National Lab. Contract W-7405-Eng-26, Subcontract No. 913. 24p. (ME-790-617A)

A perturbation treatment is given of the stress distribution in an axi-symmetrical shell approximating a sphere or hemisphere and loaded by a uniformly distributed normal pressure. The cases of closed shells and open shells with equatorial support are treated. The convergence of the procedure is examined. (D.L.C.)

29322 (Y-1297) CAPABILITY IMPROVEMENT STUDY OF A TRACER-CONTROLLED DUPLICATING LATHE. E. B. Del Grande, W. S. Nelms, K. W. Sommerfeld, and J. W. Strohecker (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Apr. 18, 1960. Changed from OFFICIAL USE ONLY Apr. 26, 1961. Contract W-7405-eng-26. 53p.

An ultra-precision, tracer-controlled, duplicating lathe was evaluated for the purpose of reducing machine variables which affected tracing accuracy. A systematic testing of components was conducted using the twin-template method for determining machine capability. Ensuing development resulted in improving precision of existing plant equipment from a total variation of 0.0005-inch in duplicating capability to a total variation no greater than 0.0001-inch. Major areas of improvement were the tracer-valve nose and the valve extension slide. (auth)

29323 (AEC-tr-4494) MATHEMATICAL METHODS OF INVESTIGATING AUTOMATIC REGULATION SYSTEMS. V. I. Zubov. Translation of "Matematicheskie Metody

Issledovaniya Sistem Avtomaticheskogo Regulirovaniya". (A publication of the State Publishing House for the Shipbuilding Industry, Leningrad, 1959). 336p.

The nonlinear nonstationary systems of ordinary differential equations that govern the response of automatic control systems are studied. The stability of steady-state motion in nonstationary control systems is investigated. The deviations of transients from the steady-state motions are estimated. The probability characteristics of stochastic transients are found. The stability of steady-state motion is investigated in critical cases. The regions of stability are determined in the space of the initial data and in the space of the permissible values of the parameters. Solutions are obtained for certain nonstationary systems of differential equations; these solutions are applicable to an extensive class of automatic control systems. (T.F.H.)

29324 (AEC-tr-4831) THE STRENGTH OF NUCLEAR REACTOR VESSELS. Jaroslav Némec. Translated for Oak Ridge National Lab., Tenn. from Jaderná energie, 6: No. 8, 254-66(1960). 67p. (Includes original, 13p.).

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 14, Abstract No. 24223.

29325 AN INDUCTION FURNACE TO ATTAIN TEMPERATURES ABOVE 3000°C IN CONTROLLED ATMOSPHERES. L. C. F. Blackman, P. H. Dundas, A. W. Moore, and A. R. Ubbelohde (Imperial Coll. of Science and Tech., London). *Brit. J. Appl. Phys.*, 12: 377-83 (Aug. 1961).

An induction furnace operating at 500 kc/s is described which is capable of providing temperatures in excess of 3000°C at high vacuum or in any suitable gas mixture at pressures up to 8 atmospheres. The work coil is mounted inside the furnace chamber, which can then be designed as a pressure vessel and constructed of electrically conducting steel. By this technique close coupling is provided between the work coil and the susceptor crucible: if desired, a heat treatment cycle to 3000°C can be completed in less than one minute. To avoid any contamination, the furnace is thermally uninsulated, so that all the heat dissipated in the crucible is lost by radiation, limiting its total surface area to about 20 cm² at 3500°C with a 25 kw generator. Application of the theory of induction heating shows that the effective resistance of the susceptor crucible can be increased by several methods, thus improving the heating efficiency of the furnace. The theory may also be applied for determining the resistivities of various susceptor materials at very high temperatures. (auth)

29326 EQUIPMENT OF THE RADIOISOTOPE PRODUCTION BUILDING. M. Douis. *Bull. inform. sci. et tech.* (Paris), No. 51, 22-8 (May 1961). (In French)

The equipment in the radioisotope production building followed the general conception of the building: maximum normalization of the various elements, simplicity of assembling, ease of access and possibility of rapid transfer. Some details of the dry box, the lead protection, the manipulation accessories, and the control rooms are given. (J.S.R.)

29327 RELAY SYSTEMS USING RADIOACTIVE SOURCES. J. Guizerix. *Bull. inform. sci. et tech.* (Paris), No. 51, 58-62 (May 1961). (In French)

The industrial apparatus using radioisotopes is classified according to the precision needed. Then the conception of relay apparatus is discussed with respect to the electronic arrangement and the source and its shielding. Examples of these relay systems are given. (J.S.R.)

29328 STRESSES AT NOZZLE CONNECTIONS OF PRESSURE VESSELS. Donald E. Hardenbergh (Pennsylvania State Univ., University Park). *Exptl. Mech.*, 1: 152-8(1961).

The presence of a nozzle in a pressure vessel creates a region of increased localized stress in the vicinity of the opening. Experimental data which show the general state of stress at nozzle openings are provided. Techniques and methods used in analyzing three insert-type nozzles when loaded by internal pressure are reported. (auth)

29329 SOURCES OF QUASI-MONOENERGETIC GAMMA RADIATION. A. H. W. Aten, Jr. and M. G. Heijzenbrok (Inst. for Nuclear Physics Research, Amsterdam). *Intern. J. Appl. Radiation and Isotopes*, 11: 38-42 (Aug. 1961). (In English)

A series of approximately monoenergetic γ -ray sources is discussed. Co^{60} is satisfactory as such, but Cs^{137} , Se^{75} and Eu^{155} can be made more nearly monoenergetic if the material is surrounded by suitable filters. (auth)

29330 INVESTIGATION ON THE SILVER-ZINC STORAGE BATTERY WITH RADIOACTIVE Ag^{110} ISOTOPE.

Tivadar Z. Palagyi (Central Research Inst. for Chemistry, Academy of Sciences, Budapest). *J. Electrochem. Soc.*, 108: 904-6(Sept. 1961).

Experiments were carried out with cells of 10 amp-hr nominal capacity. The dimensions of the plates in the cells were $83 \times 35 \times 1$ mm and $62 \times 16 \times 2$ mm. The electrodes were mounted in a casing made of Lucite plates. The activity of electrodes in the cells opened while cycling was measured and the results are given. Non-labeled electrodes were found to be contaminated with isotope only in one of the cells. Results are also given for normally and tightly assembled cells. In the tightly assembled cells the degree of contamination of the negative electrodes with isotope was larger than in the normally or loosely assembled cells. It was concluded that both the excessively tight and the loose method of assembling are disadvantageous. (P.C.H.)

29331 STATISTICAL DESIGN OF DISCRETE-DATA CONTROL SYSTEMS SUBJECT TO POWER LIMITATION. Julius T. Tou and K. S. Prasanna Kumar (Northwestern Univ., Evanston, Ill.). *J. Franklin Inst.*, 272: 171-84(Sept. 1961).

A solution is presented for the analytical design of a digital controller in accordance with a specified optimum criterion. This approach makes use of the z-transform and the modified z-transform techniques. The analytic design procedure for discrete-data control systems subject to power limitation is developed. Attention is centered upon stationary random functions because of their frequent occurrence in control systems and their being amenable to mathematical treatment. Physical realizability and system constraints are considered and general design equations are derived. (auth)

29332 THE MINIMAL TIME REGULATOR PROBLEM FOR LINEAR SAMPLED-DATA SYSTEMS: GENERAL THEORY. C. A. Desoer and J. Wing (Univ. of California, Berkeley). *J. Franklin Inst.*, 272: 208-28(Sept. 1961).

Consideration is given to a single-input, linear, time-invariant, sampled-data system described by its state transition equation $x_{k+1} = Ax_k + f_{k+1}a$, where the control f_{k+1} is subject to the admissibility condition $|f_{k+1}| \leq 1$. Necessary and sufficient conditions for controllability with admissible controls are derived. For any system satisfying these conditions, the following problem is solved: determine a scalar valued function $f(x)$ such that if, at each sampling instant, $f(x)$ is used as a control when the system

is at state x at that sampling instant, then, given any initial state x_0 , the system will be brought to the origin in the minimum number of sampling periods. In other words, $f(x)$ constitutes an optimal strategy for the minimal time regulator problem. The function $f(x)$ is describable as follows: in the state space, a hyper-surface C is constructed; the line through x , parallel to $r_1 = -A^{-1}a$ intersects C at point c , thus $x = c + \lambda r_1$; $f(x) = \text{sat } \lambda$. (auth)

29333 CRYOSTAT FOR IRRADIATING AT 4.2°K. A. Sosin and H. H. Neely (Atomics International, Canoga Park, Calif.). *Rev. Sci. Instr.*, 32: 922-4(Aug. 1961).

A cryostat for irradiating at 4.2°K is described. In this device, it is possible to irradiate samples with no intervening foils, to measure at 4.2°K, to study annealing *in situ* to more than 100°K, and to achieve recovery beyond 350°K. A sample holder utilizing the high thermal conductivity of copper and sapphire is discussed. (auth)

29334 LES CALCULS DE LA TECHNIQUE DU VIDE. (The Calculations of Vacuum Techniques). J. Delafosse and G. Mongodin. *Vide*, 16: No. 92, 1-107(Mar.-Apr. 1961).

Methods and numerical data necessary to permit a sufficiently practical calculation of three principal phases of pumping generally found in establishing a vacuum are assembled. The three phases are the evacuation of gas enclosed in the volume of the container, the evacuation of gas imprisoned in the walls of the container, and the evacuation of a permanent contribution of gas caused by leaks or by constant degassing. Complete vacuum installations are examined beginning with existing pumps whose operational characteristics are furnished by the constructor. No calculations on the detection of leaks are given. The calculations are explained in detail for readers not having an extensive mathematics background. (J.S.R.)

29335 DESIGN OF LARGE PERMANENT MAGNETS WITH ROTATIONALLY SYMMETRICAL POLES. Dimitrije Ugrin-Sparac (Inst. "Ruder Boskovic," Zagreb). *Z. angew. Math. u. Physik*, 12: 38-53(1961). (In English)

The distributed parameter method is developed and applied to the design of large permanent magnets for studying nuclear magnetic resonance, but it is also applicable to permanent magnets of any size, provided that initial conditions are in the proper range. Two kinds of losses are distinguished: fringing in the gap and leakage from the surfaces of the magnetic materials and polecaps. Thus, design calculations arise not only from nonlinearity of the demagnetization curves but also from the fact that permeance of the air is not negligible as compared to that of the magnetic material. The method of calculation leads to oversizing the magnet, but this is good since after magnetization permanent magnets are usually stabilized due to demagnetizing fields. (N.W.R.)

29336 STRESSES IN THE CENTRAL ZONE OF A LONG PLANE SPIRAL COIL CAUSED BY THE RADIAL ELECTROMAGNETIC FORCE. A. A. Kuznetsov (Lebedev Inst. of Physics, Moscow). *Zhur. Tekh. Fiz.*, 31: 944-7 (Aug. 1961). (In Russian)

The mechanical stress in the central zone of a long single-layer plane-spiral coil was evaluated by means of the elasticity equation, considering the radial volume electromagnetic force. (R.V.J.)

29337 IMPROVEMENTS IN OR RELATING TO ELECTROSTATIC PRECIPITATORS AND TO APPARATUS FOR DETECTING THE PRESENCE OF RADIOACTIVE PARTICLES IN A GAS STREAM. Kenneth Pritchard (to Plessey Co. Ltd.). British Patent 875,991. Aug. 30, 1961.

An electrostatic precipitator of the type in which radioactive particles are deposited on a central wire electrode

s designed for longer wire electrode life. The wire is formed in the shape of a closely coiled helical spring. (D.L.C.)

29338 APPARATUS FOR IRRADIATING LIQUIDS. George Robert Weber. British Patent 875,993. Aug. 30, 1961.

An apparatus is designed for exposing liquids to actinic rays of 3500 to 4500 Å wavelength. The apparatus comprises a stacked series of glass or Plexiglas plates with compartments communicating with each other by openings so that liquid may pass between compartments, and an irradiating device directing its rays toward the compartments. (D.L.C.)

29339 METHOD AND EQUIPMENT FOR LOCATING LEAKAGE POINTS IN A HEAT EXCHANGER. (to Sulzer Frères Société Anonyme). British Patent 876,476. Sept. 6, 1961.

A method and equipment for detecting and locating leakage points in a heat exchanger are described. The heat exchanger consists of conduits connected in parallel and surrounded by a first medium; a second medium flows through the conduits under a high pressure. The method consists of adding a tracer to the second medium after traces of the second medium are detected in the first medium, which tracer enables the leakage point to be detected. The equipment consists of at least one suction point in the circuit of the first medium downstream of the conduits, and a device for admitting a tracer into the conduits. The suction point is connected to a device for detecting the presence of the second medium in the first medium and to a device for detecting the presence of the tracer in the first medium. The suction points are in the form of openings in tubes which extend generally parallel to the conduits. At least one of the suction points is displaceable transverse to the direction of flow of the first medium. The individual conduits are in the form of loops mounted in the direction of flow of the first medium. (N.W.R.)

29340 IMPROVEMENTS IN AND RELATING TO PIPES FOR CONVEYING LIQUIDS AT HIGH TEMPERATURE. Andre Huet. British Patent 876,658. Sept. 6, 1961.

A piping system for fluids at a temperature of the order of 600°C or above is described. The system consists of two metallic, co-axial tubes spaced apart of which the inner tube is provided externally with radially extending members. The extremities of these radially extending members are spaced from the inner wall of the outer tube by a distance dependent on the degree of expansion of the inner tube and the working temperature of the members. Heat insulation material is disposed between the two tubes. The radially extending members may consist of discs spaced apart on the inner tube or extremities formed integrally with the inner tube. The system may involve an outer tube which is made up of rings spaced longitudinally of the system and joined together by sleeves. The rings are turned radially inward at the edges to form an annulus which is co-operable with one of the inner tubes extremities. (N.W.R.)

29341 A REMOTE CONTROLLED MANIPULATOR. (to Central Research Labs., Inc.). British Patent 876,736. Sept. 6, 1961.

A remote control manipulator comprising a horizontal tubular support, a master arm, and a slave arm is designed so that manipulations to the left or right of the normal working area of the slave arm can be performed in spite of the limited viewing area of the shielding window. This increase in the range of maneuverability of the manipulator is accomplished through providing means for displacing the slave arm with respect to the master arm. (D.L.C.)

29342 IMPROVEMENTS IN SEPARATING CONDENSIBLE IMPURITIES FROM GASES. Daniel Raymond Charles, Andre Jean Velte, Paul Dreyfus, and Georges Pamelard (to Commissariat à l'Energie Atomique). British Patent 876,738. Sept. 6, 1961.

An improved apparatus is designed for condensing impurities from impure gases with liquid air. The apparatus comprises a fixed vessel for containing liquid air and a removable vessel, the two vessels defining a small annular passage for the passage of the impure gas past the cold surface. The apparatus is suitable for purifying gases in the pumping circuit of a mass spectrometer. (D.L.C.)

29343 CENTRIFUGE DEVICE AND FLUID SEPARATION SYSTEMS EMPLOYING SUCH DEVICES. (to United Kingdom Atomic Energy Authority). British Patent 876,793. Sept. 6, 1961.

A centrifuge and pump construction is designed for use in a multi-stage gas separation system to induce forward and reflux circulation of the gases both through the system and the individual centrifuges. In this design, gas leakage is minimized by eliminating the glands, bearings, etc., that would be required if independent pumps were employed in conjunction with the individual centrifuges. (D.L.C.)

29344 REMOTE-CONTROLLED MANIPULATING APPARATUS FOR MANIPULATING OBJECTS INSIDE SEALED CHAMBERS. (to Commissariat à l'Energie Atomique). British Patent 876,898. Sept. 6, 1961.

An improved telemanipulator of the type described in British Patent No. 873,441 is given. Manipulation of objects inside a sealed chamber is effected by a magnet disposed outside the chamber coupled to a second magnet inside the chamber. In the improved telemanipulator, transmission of commands from the control arms actuated by the operator to the controlling external magnet is effected by means of electric cables. In this way, the telemanipulator is made easier to handle and less bulky. (D.L.C.)

29345 POWER DRIVEN CENTRIFUGES AND LIKE ROTATING DEVICES. (to United Kingdom Atomic Energy Authority). British Patent 876,910. Sept. 6, 1961.

A centrifuge is designed with a vibration damping structure. The damping structure comprises the bearings spaced apart axially at distances different from the spacing of the vibration nodes at critical speeds. (D.L.C.)

29346 IMPROVEMENTS IN OR RELATING TO SAMPLING DEVICES. Ian James Smith, Michael John Larkin, and John Walton Marshall (to United Kingdom Atomic Energy Authority). British Patent 876,975. Sept. 6, 1961.

A sampling device is described for taking a representative sample from a stream of radioactive liquid over a period of several hours. The device consists of a sampling tube, a first pipe connection from the tube to a sampling bottle sealed by an elastomer cap, and a second pipe connection from the bottle to means for applying a steadily increasing partial vacuum to the tube. The pipe connections have pointed ends which penetrate the elastomer cap. (N.W.R.)

29347 VALVES FOR CONTROLLING GAS STREAMS FLOWING AT VERY LOW FLOW RATES. Pierre M. Roubeau, Jean-Marie Garin, and Pierre Prugne (to Commissariat à l'Energie Atomique). Canadian Patent 620,840. May 23, 1961.

A gas valve for very low flow rates is designed which may be used to supply gas to ion sources or to measure the pumping rate of a molecular vacuum pump. The valve contains a needle-seat member which is adjustable by thermal expansion. Graphs are presented showing the effects of diametrical play, pressure, and adjustment parameters on the flow rate. (D.L.C.)

Heat Transfer and Fluid Flow

Refer also to abstracts 30233 and 30306

29348 (ANL-6369) ON THE MEASUREMENT OF THE DYNAMIC PROPERTIES OF THE STEAM VOID FRACTION IN BOILING WATER CHANNELS. Ahti Tapio Eurola (Argonne National Lab., Ill.). June 1961. Contract W-31-109-eng-38. 61p.

The problem of determining the dynamic properties of the steam void fraction undergoing random variations at a particular location in a boiling channel was studied. Emphasis was placed on a gamma attenuation method and on a method employing sensitive flowmeters at suitable locations of the channel. The dynamic properties of interest were the autocorrelation function and the power density spectrum of the variations. Equations were derived for computing the desired quantities on the basis of gamma records obtained during actual boiling experiments and from runs with empty and full, nonboiling channels. The equations consider the statistical variations of the gamma source and detector. A procedure was outlined for estimating the measurement effort to obtain a predetermined accuracy. Two models were developed to correlate the variations of flow with fluctuations of the steam void. Both models were based on the mass continuity equation for a two-phase fluid. The simpler model leads to a first-order, linear differential equation with randomly varying coefficients. The desired quantities can be computed from the equation. The second model leads to a linear integral equation of the third kind. This equation relates the power density spectrum of the void fraction with the spectra of the water velocities. A frequency range from zero to five cycles per second was investigated. A comparison of the results obtained with the gamma-ray and velocity methods on a 42-atm heat-transfer loop indicated that neither model satisfactorily relates the velocity variations with the steam void variations over the entire range of frequencies studied. However, if the steam transit time is about 0.1 sec and the frequency range of interest less than one cycle per second, both models are useful and have approximately the same accuracy. At frequencies greater than one cycle per second, the deviation from the gamma results is more than three decibels for a 0.1-sec steam transit time. The second model gives slightly better results than the first. The accuracy of the models increases with decreasing steam transit time. (auth)

29349 (ANL-6381) A THEORETICAL STUDY OF THE TRANSIENT OPERATION AND STABILITY OF TWO-PHASE NATURAL CIRCULATION LOOPS. Kermit Garlid, N. R. Amundson, and H. S. Isbin (Minnesota. Univ., Minneapolis). June 1961. For Argonne National Lab. Contract W-31-109-eng-38, Subcontract 31-109-38-1092. 83p.

Thesis submitted by Kermit Garlid to Univ. of Washington, Seattle.

Mathematical models of the time-dependent behavior of two-phase natural-circulation loops were used to predict the operation and to explain the unusual instability sometimes observed. The initial results obtained for a loop similar to the Univ. of Minnesota loop were used to formulate a more complex and accurate model, and the predicted transient behavior was in close agreement with the experimental results from the Minnesota loop. For a 300-psia, high-pressure loop, unstable oscillatory behavior was predicted under certain conditions and stable behavior under others. Closed unstable regions rather than limits were predicted, and the specifications of stability in terms

of a single parameter were found to be impossible. The great difference in oscillatory frequencies observed at low and high pressures was found to be due largely to the system geometry. The criterion for the absence of oscillations was found to be similar to one of the criteria for stability of chemical reaction systems. (D.L.C.)

29350 (ANL-6400) AN EXPERIMENTAL INVESTIGATION OF HIGH-FLUX FREE CONVECTION HEAT TRANSFER TO WATER UP TO NEAR-CRITICAL CONDITIONS. Vernon Emerson Holt (Argonne National Lab., Ill.). Aug. 1961. Contract W-31-109-eng-38. 113p.

An investigation was made to increase the basic knowledge of nucleate and film boiling heat transfer to fluids up to their critical pressures. An extensive literature survey of the subject indicated a scarcity of consistent data and an absence of proven methods for analysis. This situation led to the design and construction of experimental apparatus suitable for measuring rates of free convection heat transfer and associated temperature differences for fluid conditions up to 4000 psi and 800°F, with provision for visual observation. The apparatus incorporated a stainless steel system for containing the fluid. Ten-mil-diameter cylindrical and $\frac{1}{8}$ -in.-high vertical-plate platinum test sections were placed in the fluid inside a pressure vessel, 5 in. in inside diameter and 21 in. high. The pressure and temperature of the fluid environment were controlled by constant-volume heating of the fluid in the pressure vessel with the aid of seven zones of radiant guard heaters located between the external wall of the pressure vessel and the insulation. Each of these zones was controlled by a differential-thermocouple-sensed circuit that automatically kept the pressure vessel at a prescribed uniform temperature. Fluid pressure was measured with a dead-weight tester and a 0-4000-psi Heise gauge. Fluid temperature was measured with a calibrated resistance thermometer and Mueller bridge, purchased specifically for that purpose. The heat flux in the test section was obtained from electrical measurements of the direct-current power supplied for Joule heating. The temperature of the test section was measured by means of a resistance thermometer. The system was outgassed and filled under a vacuum with water that was deionized, degassed, and deionized again. The quality of the water was maintained during an experiment with the aid of a thermal-siphon deionizing loop which was connected to the system. The results were tabulated and plotted in terms of heat flux and temperature difference between the heated surface and the bulk fluid (water). Nucleate boiling results are included for pressures of 14.7, 1300, 2400, 2800, 2900, 3000, 3100, 3150, and 3180 psia. Film boiling results are included for pressures of 2400, 2800, 2900, 3000, 3100, 3150, and 3180 psia. Results also included for free convection to water at pressures of 3200, 3250, 3300, 3400, 3625, and 3925 psia. The nucleate and film boiling results were correlated and compared with other data. At a particular nucleate boiling heat flux, the heat transfer coefficient was observed to increase with pressure up to about 2800 psia. The characteristics associated with transition film boiling vanished above the critical pressure according to the plotted results and the experimental behavior. In fact, for pressures above the critical, a trend toward the characteristics associated with single-phase free convection to a constant-property fluid was observed. A large convective flow of the fluid and large density gradients accompanied by considerable optical distortion were observed within ± 400 psi of the critical pressure. Near the critical pressure, sheets of fluid appeared to be passing the field of observation. (auth)

29351 (APEX-659) THE ELASTIC-PLASTIC STRESSES WITHIN A TUBE GENERATING INTERNAL HEAT UNIFORMLY. Bernard W. Shaffer (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Apr. 28, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 35p.

Equations are derived for the elastic-plastic stresses and displacements within a thick tube generating internal heat uniformly. The tube is assumed to be perfectly plastic and obey the Tresca yield condition and the associated flow law. Yielding starts at the internal surface of the tube where two plastic zones originate simultaneously. As the rate of internal heat generation increases, the concentric plastic zones expand so that one always encompasses the internal boundary of the tube while the other is enclosed by the elastic region. (auth)

29352 (CF-61-6-16) HEAT TRANSFER ANALYSIS OF PEBBLE BED REACTORS AND COMPARISON WITH PRISMATIC CORES. N. Ozisik, R. B. Korsmeyer, and G. L. Rhoden (Oak Ridge National Lab., Tenn.). June 19, 1961. 56p.

The general analytical equations relating the core-power density and the gas-film temperature drop at the fuel surface to the principal reactor parameters are presented for both axial-flow and radial-flow pebble bed cores. Charts are included which show the power density and gas-film temperature drop as functions of fuel-ball diameter, pumping power-to-heat removal ratio, gas temperature rise per unit length of gas passage, and the gas pressure. The effects of voidage, system temperature and gas properties are considered along with factors causing hot spots. The effects on interior temperature of variations in the gas film heat transfer coefficient around the fuel surface were investigated. Neglecting hot spots, the power density obtainable in the prismatic core is more than four times that of the pebble bed core for equal maximum fuel temperatures. The extra degree of freedom available in design of prismatic core coolant passages permits the designer always to select a combination of parameters that is superior to the optimum combination for the pebble bed reactor. It is therefore clear that the fuel handling system, including perhaps the reactor maintenance, will have to be considerably more economical in the case of the pebble bed reactor in order for that reactor to compete with its prismatic counterpart. (auth)

29353 (CUA-NE-14) SIMULATED NUCLEAR REACTOR VIBRATIONAL HEAT TRANSFER. Quarterly Progress Report, February 1, 1961-April 30, 1961. (Catholic Univ. of America, Washington, D. C.). Contract AT(30-1)-2655. 10p.

Activities are reviewed for work done in studies of the effects of vibrations on convective heat transfer to water for simulated reactor heat transfer investigations. A summary is presented of the technical aspects of previous studies of vibration effects on heat transfer. 19 references. (B.O.G.)

29354 (GEAP-3397(Rev. 1)) NATURAL CIRCULATION LOOP PERFORMANCE AT 1000 PSIA UNDER PERIODIC ACCELERATIONS. PART I. INITIAL EXPERIMENTAL RESULTS. E. P. Quinn. PART II. ANALOG PREDICTION OF FLOW CHARACTERISTICS. J. M. Case (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). May 6, 1960. Contract AT-(04-3)-189. 80p.

Initial experimental and analog results were obtained from a study of the effect of shipboard disturbances on the heat transfer and fluid flow performance of boiling water reactors. The experimental part of the program was con-

ducted employing a single element, electrically heated, simulated reactor model. The natural circulation model was subjected to pendulum type and constant accelerations for a total of 35 test conditions. Amplitudes of motion were from 0 to 40 degrees about the vertical for frequencies of 0 to $\frac{1}{2}$ cycles per second. The accelerations ranged in magnitude from 0.7 to 1.7 g. The span of thermodynamic conditions at 1000 psia were heat fluxes of 200,000 to 500,000 Btu/hr ft², subcoolings of 60 to 200 Btu/lb, and qualities of 6 to 60%. Variations due to motion extend from about 10 to 60% of the average flow for acceleration oscillations of 10 to 50%. A correlation of these variations was proposed on the basis of an average driving pressure, which may reduce the experimental investigation to stationary testing. Hydraulic instability was not observed during this part of the program. Thresholds of instability under varying accelerations remain to be investigated, but based on initial data they do not appear to be unexpectedly affected by ship's motion. Three burnout tests were performed. Based on this, the motion does not appear to pose a problem. Fluctuations of heating element temperature, which were found to be related to the motion, occurred before burnout. Oscillating operation at heat fluxes below 350,000 Btu/hr ft² with qualities below 32% indicated steady heater temperatures and no tendency toward burnout. An analog computer model, based on descriptive equations, was used to predict reactor behavior under periodic variations in acceleration. Three comparisons were made between the analog results and experimental observations. Qualitatively, this analytical model predicts the observed flow behavior and stability. The mean deviation from the measured flow characteristics was 4% high. The initial satisfactory comparison between the tests and simplified analog model tended to increase confidence in the ability to analytically predict the effects of ship's motion on reactor circulation. (auth)

29355 (NAA-SR-MEMO-6433) GENERALIZED CURVES FOR RADIATION AND FREE CONVECTION HEAT TRANSFER WITH AIR. C. J. Baroczy (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 20, 1961. 19p.

A group of generalized curves was formulated, in nomograph form, which permit the rapid, accurate determination of the free convection heat transfer coefficient for any surface in air, under heating or cooling conditions. Since, with free convection heat transfer, radiation cannot be neglected, curves were also devised for determining the radiation heat transfer coefficient. For each mode of heat transfer the required calculation work was minimized and simplified. Numerical examples are included. (auth)

29356 (NAA-SR-Memo-6593) ANALYSIS OF SOME OF THE EDGE EFFECTS IN SHELL SIDE HEAT TRANSFER. J. S. McDonald (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 19, 1961. 18p.

An estimate was made of the relative heat transfer for internal as a function of peripheral tubes by an approximation assuming tube continuums to replace tube columns. Characteristic velocity profiles were assumed with the turbulent core being characterized by the $1/7$ law and a laminar sublayer taken to exist adjacent to the surfaces. Using these velocity distributions the energy equation was solved numerically for various situations. To determine the momentum eddy diffusivity it was assumed that the shear varied linearly from zero at the passage center line to $\tau_w = 0.0271\rho u_\tau^2 (v/u_\tau \delta)^{1/2}$ at the wall. Heat transfer coefficients were calculated for a range of conditions and results were found to agree fairly well with the limited ex-

perimental information available in the literature. The ratios of film coefficients for peripheral tubes to coefficients for internal tubes varied from ≈ 0.85 to 0.98. (auth)

29357 (NP-10572) THE HEAT TRANSFER CHARACTERISTICS OF GASEOUS HYDROGEN AND HELIUM. J. R. McCarthy and H. Wolf (Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif.). Dec. 1960. 381p. (RR-60-12)

Heat transfer experiments are described that were conducted with hydrogen and helium gas flowing turbulently in smooth, round, electrically heated tubes. Values of the ratio of wall-to-fluid temperature from 1.6 to 11.1 were achieved by lowering the inlet temperature of the gas in a liquid nitrogen intercooler. Bulk Reynolds numbers ranging from 4,000 to 1,500,000 and inlet temperatures of the gas as low as 135°R (-325°F) were obtained in the experiments. Measurements were made of the pressure drop along the length of the test section in adiabatic and in diabatic flow. The results are presented in tabular and in graphical form. Correlation of the results was achieved by including the term $(T_w/T_b)^a$ in the Nusselt equation. Values of the correlation exponent, a , are presented for the reference temperatures employed for evaluating the transport properties of the gas. The presence of acoustic resonance in the flow was found to increase the heat transfer coefficient by as much as a factor of two. (auth)

29358 (NP-10639) IONIZATION AND RADIATION IN RE-ENTRY FLOW FIELDS, A SELECTIVE BIBLIOGRAPHY. George E. Owens, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). June 1961. Contract NOrd 17017. 46p. (SB-61-34)

References (117) are given to books, reports, and U. S. and foreign journals published from 1949 to March 1961. An index on secondary authors and corporate sources and sponsors is also included. (P.C.H.)

29359 (NP-10648) APPLICATION OF A HYDROCARBON TRACER TECHNIQUE TO GAS PHASE MASS TRANSFER INVESTIGATIONS. Technical Report No. 50. J. C. Schulz (Stanford Univ., Calif.). Aug. 1, 1961. Contract Nonr 225(23). 55p.

A technique for measuring mass transfer in a fluid flow situation is described which uses small concentrations of hydrocarbon tracer gas in conjunction with a sensitive hydrocarbon detector. The detector, based on the principle of flame ionization, gives a full-scale response on its most sensitive range to a sample containing 0.0001 mole % methane. The technique is illustrated by applying it to the case of turbulent jet mixing in an air-air ejector. Ethane is used as the tracer gas in the range 0 to 0.04 mole %. Nondimensional concentration profiles are obtained showing the spread of concentration in the mixing region. Comparison with velocity and temperature data obtained by Mitchell indicates that temperature and mass spread alike while the spread of velocity is slower and of a different nature. (D.L.C.)

29360 (NP-10657) THERMAL RESISTANCE OF METAL-TO-METAL CONTACTS: AN ANNOTATED BIBLIOGRAPHY. Robert C. Gex, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). July 1961. Contract AF04(647)-673. 23p. (SB-61-39).

Forty-four annotated references on heat transfer through metallic contacts are included. Emphasis is placed on thermal contact resistance in a vacuum. Welded and bonded joints are not included. Most of the information abstracted relates to the technologies of aircraft structural design and nuclear reactor design. (auth)

29361 (NYO-9647) BASIC STUDIES IN HEAT TRANSFER AND FLUID FLOW. Quarterly Progress Report for Period April 1, 1961 to June 30, 1961. T. Diskind, D. Lee, R. Lummis, and J. Vohr (Columbia Univ., New York. Engineering Research Labs.). June 30, 1961. Contract AT(30-3)-187. 61p. (IX-QPR-2-61)

Nucleate boiling and burnout experiments were conducted with hollow nickel heaters. Data accumulated from the work are presented in graphical and tabular form. Transient vaporization analyses were carried out which predicts, for certain cases, the non-boiling response of the heater-liquid system to power input transients. Expressions were derived for the heat flux density into the liquid and for the instantaneous temperature at the solid-liquid interface, in the two limiting cases of very low frequency and very high frequency heat generation. A discussion is given of the design and evaluation of a Cyclical Optical Scanner for obtaining optical density traces on high-speed motion picture film of two-phase flow patterns. Convection heat transfer studies were made for a 92% eccentric annulus in which variations were made in water velocities of 3 to 24 fps, heat generation rates of 40,000 to 340,000 Btu/(hr)(ft²), and Reynolds numbers of 20,000 to 250,000. Measurements made during the tests were: electric current, voltage at 6 points along the heater tube, inlet and outlet water temperatures, test section pressure, and water flow rate. Calculations were made for: bulk average water temperature at each thermocouple level, circumferential average heater tube surface temperature at each level, heat generation rate, and average heat transfer coefficient. (B.O.G.)

29362 (WCAP-1645) FLOW REDISTRIBUTION IN AN OPEN LATTICE CORE. L. S. Tong, G. Previti, and R. Berringer (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Oct. 1960. 16p.

Two combination mathematical and physical models of the flow redistribution caused by bulk boiling within an open lattice core were developed. One model considers the influences of the transverse pressure gradient across the channels while the other does not. The validity of the equations of both models was shown by hand calculation of the flow redistribution in the Saxton Reactor Core. (auth)

29363 (AEC-tr-4799) THEORETICAL STUDY OF THE INFLUENCE ON SURFACE TEMPERATURE OF A GEOMETRICAL PERTURBATION OF WALL OF AN ELECTRICALLY HEATED CHANNEL. R. Gerber (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Translated by M. S. Feldman for Savannah River Lab., Aiken, S. C., from Report CEA-1430, 1960. 22p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 15, abstract no. 2732.

29364 (AEC-tr-4802) HYDRAULIC RESISTANCES OF TUBES IN THE CASE OF RISING FLOW OF A STEAM-WATER MIXTURE AT HIGH VELOCITIES AND HIGH AND ULTRA-HIGH PRESSURES. M. M. Przhivalkovskii and I. N. Petrova. Translated from *Teploenergetica*, 8: No. 6, 25-8(1961). 7p.

The hydraulic flow resistances of tubes of 6 to 16 mm diam. were determined for steam-water mixtures at pressures of 100 to 200 atm. absolute, mass flow rates >1000 kg/m²sec, and vapor contents of 0 to 100%. The results are plotted as ratio of resistance for steam-water mixtures to resistance for water at saturation temperature vs the vapor content. For vapor contents ≥ 0.75 , the rate of increase of hydraulic resistance decreases with increasing vapor content. This effect is explained in terms of a re-

orientation of the physical state of the mixture, resulting in the water film breaking off from the tube wall. (D.L.C.)

29365 (RAE-LIB-Trans-873) THE CRITICAL THERMAL LOAD IN THE BOILING OF LIQUIDS IN LARGE VOLUME. M. A. Styrikovich and G. M. Polyakov. Translated by J. W. Palmer for Gt. Brit. Royal Aircraft Establishment from Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, No. 5, 652-6(1951). 8p. (AD-236634)

The critical thermal loads obtained in experiments with a 5×300 mm plate heated electrically in various liquids are given for the plate facing upward, facing downward, and vertical. The results are compared with previous results with thin wires and vapor-heated tubes. (auth)

29366 A FINITE-DIFFERENCE METHOD OF HIGH-ORDER ACCURACY FOR THE SOLUTION OF THREE-DIMENSIONAL TRANSIENT HEAT CONDUCTION PROBLEMS. P. L. T. Brian (Massachusetts Inst. of Tech., Cambridge). A.I.Ch.E. Journal, 7: 367-70(Sept. 1961).

A finite-difference method is presented for solving three-dimensional transient heat conduction problems. The method is a modification of the method of Douglas and Rachford which achieves the higher-order accuracy of a Crank-Nicholson formulation while preserving the advantages of the Douglas-Rachford method: unconditional stability and simplicity of solving the equations at each time level. Although the method is not applied, the analysis suggests that it will prove to be the most efficient method yet proposed for the numerical integration of three-dimensional transient heat conduction problems. (auth)

29367 TRANSPORT CHARACTERISTICS OF SUSPENSIONS: II. MINIMUM TRANSPORT VELOCITY FOR FLOCCULATED SUSPENSIONS IN HORIZONTAL PIPES. David G. Thomas (Oak Ridge National Lab., Tenn.). A.I.Ch.E. Journal, 7: 423-30(Sept. 1961).

The minimum transport velocity was determined for flocculated thorium oxide and kaolin suspensions flowing in glass pipes. The pipes ranged from 1 to 4 in. in diameter, and the concentration was varied from 0.01 to 0.17 volume fraction solids. Two flow regimes were observed depending on the concentration of the suspension. In the first the suspension was sufficiently concentrated to be in the compaction zone and hence had an extremely low settling rate. The second regime was observed with more dilute suspensions which were in the hindered-settling zone and settled ten to one-hundred times faster than slurries which were in compaction. The concentration for transition from one regime to the other was dependent on both the tube diameter and the degree of flocculation. The suspension particles were smaller than the thickness of the laminar sublayer, and they settled according to Stokes' law for the particular conditions of this study. Under these circumstances the relation developed for dilute suspensions is consistent with particle transfer in the radial direction owing to Bernoulli forces on the particle and the action of turbulent fluctuations which penetrate the laminar sublayer. For concentrated suspension in compaction the minimum transport velocity was given by a characteristic critical Reynolds number. (auth)

29368 TRANSPORT CHARACTERISTICS OF SUSPENSIONS: III. LAMINAR-FLOW PROPERTIES OF FLOCCULATED SUSPENSIONS. David G. Thomas (Oak Ridge National Lab., Tenn.). A.I.Ch.E. Journal, 7: 431-7(Sept. 1961).

The principal factors affecting the magnitude of the laminar-flow properties of flocculated suspensions were the concentration and particle diameter of the solid phase.

The range of variables included concentrations from 0.02 to 0.23 volume fraction solids and particle sizes from 0.35 to 13 μ . Materials tested included thorium oxide, kaolin, titanium oxide, aluminum oxide, graphite, magnesium oxide, and uranium dioxide. At high rates of shear the data were fitted satisfactorily with the Bingham plastic model. The yield stress was directly proportional to the cube of the volume fraction solids and inversely proportional to the first or second power of the particle diameter, depending on the particle shape. The logarithm of the ratio of the coefficient of rigidity of the suspension to the viscosity of the suspending medium was directly proportional to the volume fraction solids over the complete range of concentrations studied. Although specific electrolytes (such as oxalate or pyrophosphate) deflocculated the suspensions even at low concentrations, the suspensions remained flocculated both in the presence of up to 0.1 M of 1:1 electrolyte and over a pH range of 4 to 12. (auth)

29369 LAMINAR BOUNDARY LAYER FLOW AND HEAT TRANSFER PAST A FLAT PLATE FOR A LIQUID OF VARIABLE VISCOSITY. O. T. Hanna and J. E. Myers (Purdue Univ., Lafayette, Ind.). A.I.Ch.E. Journal, 7: 437-41(Sept. 1961).

A solution for the problem of incompressible laminar boundary-layer flow and heat transfer with variable viscosity is presented. Because of the variation of viscosity with temperature the velocity and temperature fields interact mutually. This necessitates the simultaneous solution of the momentum and energy equations. The analysis is carried out for the case where heating begins at the leading edge of the plate. The results show the effect of the important variable property parameters on the friction factor and the heat transfer coefficient. These parameters are seen to be the temperature difference between wall and free stream, the viscosity temperature variation law, and the Prandtl number at the wall. The results are applicable to liquids. (auth)

29370 TAYLOR INSTABILITY OF AN EVAPORATING PLANE INTERFACE. S. G. Bankoff (Northwestern Univ., Evanston, Ill.). A.I.Ch.E. Journal, 7: 485-7(Sept. 1961).

A new mode of high-flux heat transfer is proposed, which consists of film boiling from a porous solid plate, the vapor being sucked off through the plate. For horizontal plates the average vapor film thickness is determined by Taylor instability of the vapor-liquid interface. A theory is presented for predicting the minimum vapor film thickness which takes into account the stabilizing influence of the reactive pressure of the vapor leaving the interface. The predicted heat transfer coefficients are five to ten times greater than observed heat transfer coefficients in film boiling from nonporous surfaces. (auth)

29371 KINETICS OF CARBON DEPOSITION IN A FLUIDIZED BED. Joseph H. Oxley, Arthur C. Secrest, Neil D. Veigel, and John M. Blocher, Jr. (Battelle Memorial Inst., Columbus, Ohio). A.I.Ch.E. Journal, 7: 498-501(Sept. 1961).

Rate data were obtained for the deposition of carbon films from methane and acetylene in fluidized beds of alumina, uranium dioxide, uranium monocarbide, uranium dicarbide, and a solid solution of uranium-thorium dicarbide powders. These carbon films were shown to provide excellent protection for the powdered fertile material against attack by hot concentrated nitric-acid solutions. The coated uranium-thorium dicarbide particles were also shown to be stable in humid air. (auth)

29372 HEAT TRANSFER FOR TURBULENT FLOW OF A LIQUID METAL IN A TUBE. V. I. Subbotin, M. Kh. Ibragimov, M. N. Ivanovskii, M. N. Arnol'dov, and E. V.

Nomofilov. *Atomnaya Energ.*, 11: 133-9 (Aug. 1961). (In Russian)

The radial temperature distribution in a -30 mm stainless steel tube was determined for alkali metal at Reynolds number of 16,200 and 24,700 and at heat flows of 40,000 and 39,500 kcal/m²/hr, and for heavy metals at Reynolds numbers of 24,200 and 204,000 and at heat flows of 17,800 and 41,000 kcal/m²/hr. The wall temperature which was required to calculate the heat transfer coefficient was determined by extrapolating the temperature profile of the liquid metal to the temperature of the wall. The data fit the formula of R. Lyons over a wide range of Peclet numbers of 100 to 12,000: $Nu = 7 + 0.025 Pe^{0.8}$. However, if the contact thermal resistance due to the oxide film on the heavy metals is taken into account, the points for the heavy metals fall below the curve for the liquid alkali metals on a plot of Nusselt numbers versus the Peclet numbers. The contact thermal resistance for the heavy liquid metal is plotted as a function of the Reynolds number. Chemical analysis showed that the content of oxide near the wall was about a factor of ten greater than the content of oxide in the main stream of the heavy metal. (TTT)

29373 ON BOURRET'S HYPOTHESIS CONCERNING TURBULENT DIFFUSION. P. H. Roberts (King's Coll., Newcastle-upon-Tyne, Eng.). *Can. J. Phys.*, 39: 1291-9 (Sept. 1961).

An integrodifferential equation proposed on heuristic grounds by Bourret for turbulent diffusion is compared with a similar equation derived by Roberts from the application of Kraichnan's approximation to the exact equations of turbulent diffusion, and which is itself closely related to an equation postulated by Bourret as a result of further heuristic arguments. A simple generalization of Taylor's model of turbulent diffusion is discussed, and is found to obey Roberts' equation but, unless the spacial correlation between the velocity of the diffusing particles is zero, it does not obey the equation initially proposed by Bourret. (auth)

29374 HEAT TRANSFER BY GASEOUS HYDROGEN IN TURBULENT FLOW THROUGH A TUBE AND IN A SMOOTH-WALLED ANNULAR SPACE. Alain de La Harpe and Paul Perroud (Centre d'Etudes nucleaires, Grenoble, France). *Compt. rend.*, 252: 385-7 (Jan. 16, 1961). (CEA-1916). (In French)

Modifications that have to be applied to the Colburn formula, $Nu = 0.023 Re^{0.8} Pr^{0.4}$, for it to remain valid in the case of various flow diagrams, for all temperature differences between the fluid and the heating wall, are sought. (auth)

29375 FLOW MODELS IN BOUNDARY-LAYER STALL INCEPTION. V. A. Sandborn (Lewis Research Center, Cleveland) and S. J. Kline. *J. Basic Eng.*, 83: 317-27 (Sept. 1961).

Physical evidence on stall inception from visual studies, mean-velocity-profile correlations, shear measurements, and fluctuations in separating boundary layers in the neighborhood of stall are discussed. Direct visual studies suggest that stall inception in the laminar boundary layer follows the classical model, but does not necessarily do so in the turbulent shear layer. It is useful to describe stall as a certain type of transition region, which can be long or short. Adoption of these ideas is shown to lead to better correlation of stall data and more complete understanding of available physical evidence. However, physical data on the relation between the various types of evidence in the turbulent case and their respective connections with the events in the transition region leading to stall are not presently complete. (auth)

29376 GENERALIZATION OF A CLASS OF SOLUTIONS OF THE LAMINAR, INCOMPRESSIBLE BOUNDARY-LAYER EQUATIONS. Ward O. Winer and Arthur G. Hansen (Univ. of Michigan, Ann Arbor). *J. Basic Eng.*, 83: 328-32 (Sept. 1961).

The momentum, continuity, and energy equations of the laminar incompressible boundary layer in a skew-linear co-ordinate system are similar in form to those in a rectangular co-ordinate system. This fact is used to generalize the requirements for similarity solutions in rectangular co-ordinates. The requirements for all possible similarity solutions of the boundary-layer and energy equations in skew-linear co-ordinates are presented. The usual Cartesian co-ordinate system is a special case of co-ordinate systems considered. (auth)

29377 INLET AND EXIT-HEADER SHAPES FOR UNIFORM FLOW THROUGH A RESISTANCE PARALLEL TO THE MAIN STREAM. Morris Perlmutter (Lewis Research Center, Cleveland). *J. Basic Eng.*, 83: 361-70 (Sept. 1961).

An analytical and experimental study of flow in headers with a resistance parallel to the turbulent and incompressible main stream was made. The purpose was to shape the inlet and exit headers, which had a large length-to-height ratio, so that the fluid would pass through the resistance uniformly. Analytical wall shapes and estimated total pressure drop through the headers were compared with experimental results. Good agreement between analysis and experiment was found for the cases compared. (auth)

29378 LINEARIZED SLIP FLOW PAST A SEMI-INFINITE FLAT PLATE. J. A. Laurmann (Ames Research Center, Moffett Field, Calif.). *J. Fluid Mech.*, 11: 82-96 (Aug. 1961).

Incompressible slip flow past a semi-infinite flat plate at zero incidence is treated in terms of the linearized viscous flow equations. A formal solution is obtained using Fourier transforms and the Wiener-Hopf technique. Explicit inversion of the transform is not possible but asymptotic expansions are discussed. These reveal the inadequacy of boundary-layer theory in predicting the nature of the solution, even at the plate surface. For example, the local shear forces on the plate are significantly different from boundary-layer values, even far downstream, where slip effects are small. The boundary-layer limit is approached as the Reynolds number based on the mean free path or the free-stream Mach number tends to infinity. (auth)

29379 EQUILIBRIUM LAYERS AND WALL TURBULENCE. A. A. Townsend (Emmanuel Coll., Cambridge, Eng.). *J. Fluid Mech.*, 11: 97-120 (Aug. 1961).

In turbulent flow past rigid boundaries, there can be distinguished regions close to the wall in which the local rates of energy production and dissipation are so large that aspects of the turbulent motion concerned with these processes are determined almost solely by the distribution of shear stress within the region and are independent of conditions outside it. These regions are called equilibrium layers because of the equilibrium existing between local rates of energy production and dissipation. The properties of these various equilibrium layers are considered and the distributions of mean velocity are derived from the equation for the turbulent kinetic energy and certain assumptions of flow similarity. The theory of self-preserving wall flow, usually expressed as a combination of the law of the wall and defect law, assumes compatibility between the outer flow and the equilibrium layer, and the course of development depends on the kind of equilibrium layer. Ear-

lier work, which assumed the defect law, is only valid if the whole of the equilibrium layer is a constant-stress layer and this is not true in strong adverse pressure gradients. A consistent theory is developed for these flows by assuming a linear-stress layer, and the solutions show the relation between flows of finite stress and of zero stress and provide a plausible explanation of the phenomenon of downstream instability observed by Clauser. Self-preserving flow in wedges is treated on similar lines. (auth)

29380 THE INVESTIGATION IN SUPERSONIC THERMAL EXCHANGE BY SUPERSONIC FLOW OF GAS THROUGH THE PIPE OF LAMINAR BOUNDARY LAYER. A. E. Marenov (Inst. of Mechanics, Academy of Sciences, Moscow). Zhur. Tekh. Fiz., 31: 1001-11 (Aug. 1961). (In Russian)

Descriptions are given of an experimental determination of heat exchange in supersonic air flow in a cylindrical tube with constant cross section. It was observed that the laminar boundary is retained along the larger portion of the tube. The gas flow is not stabilized along the tube length, therefore, the heat exchange coefficient varies, diminishing from the entrance to the exit. As a critical value Re_x , the laminar boundary layer becomes turbulent with a sharp increase in heat exchange coefficients. (tr-auth)

29381 LOCAL PRESSURE GRADIENTS FOR SUBCOOLED BOILING OF WATER IN VERTICAL TUBES. W. L. Owens (Univ. of Aberdeen, Scotland) and V. E. Schrock. Paper Number 60-WA-249 of "Winter Annual Meeting, New York, N. Y., November 27-December 2, 1960, of The American Society of Mechanical Engineers." New York, The American Society of Mechanical Engineers, 1961. \$1.00.

When a subcooled liquid flowing in a tube is heated at a sufficiently high rate, nucleate boiling will occur on the surface. Small bubbles grow rapidly in a thin superheated layer adjacent to the wall and then collapse as they extend into the main body of the subcooled liquid. This action increases the pressure drop beyond that occurring for the same flow without subcooled boiling. Results of an experimental investigation of the pressure drop occurring in forced convection boiling of subcooled water in circular tubes are reported. (auth)

Instrumentation

Refer also to abstracts 29856, 29858, and 30301

29382 (AERE-BIB-137) AUTOMATIC SCANNING OF NUCLEAR EMULSIONS. An Annotated Bibliography. B. J. Wilson, comp. (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1961. 10p.

Thirty-six references are given to reports and U. S. and foreign books and journals published from April, 1959 to April, 1961. Separate personal author and report number indexes are included. (P.C.H.)

29383 (AFOSR-983) RECENT WORK ON INSTRUMENTATION FOR NUCLEAR PULSE-HEIGHT SPECTROSCOPY. MANUFACTURING TECHNIQUES AND PERFORMANCE OF SURFACE BARRIER SEMICONDUCTOR DETECTORS. Technical Note No. 6. B. Åström, N. G. E. Johansson, and Gunilla Wickenberg (Sweden. Kungliga Vetenskapsakademien. Nobelinstitutet for Fysik, Stockholm). June 1, 1961. Contract AF(052)-118. 6p.

Semiconductor detectors and techniques for producing

them are described. The material used for the detectors was n-type silicon with a resistivity of 300 ohm/cm or higher. Methods of treating these detector elements are outlined. A schematic diagram is presented of the vacuum chamber used to test the detectors. The equipment included a charge-sensitive preamplifier, a main amplifier, a biased post amplifier, pulse-height analyzer, and a mercury-relay pulse generator. The reverse current of one of the detectors was plotted as a function of bias voltage. A resolution curve was also measured using 0.5 μ sec differentiating and integrating time constants. Examples of alpha spectra measured with one of the detectors are given. (M.C.G.)

29384 (ARF-1184-2) MAGNETIC PROPERTIES OF INSULATORS. Quarterly Report No. 2 covering Period May 15, 1961 to August 15, 1961. Jordan J. Markham (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Aug. 30, 1961. Contract AT(11-1)-578. 54p.

The electron paramagnetic resonance (EPR) of color centers in additively colored KCl crystals is measured to observe the effects of optical bleaching at room temperature. Earlier measurements on the F-center are confirmed and the susceptibility is measured at 78 and 300°K over five decades of power, including the very low power region. The width and the saturation properties of the individual multiplets are studied in detail and the technique of making EPR measurements on inhomogeneously broadened lines is discussed. A calculation is presented which shows that a slight departure from a Lorentzian multiplet shape can account for the saturation data. The bleached crystals show a resonance which has a width of 35 gauss and a different rate of saturation than the F-center. This resonance is associated with the B-band which appears in the optical absorption. (auth)

29385 (AWRE/NR/P-6/61) THIN FILM TRANSMISSION MULTIPLIER. N. C. Fenner and H. W. Wilson (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Sept. 1961. 13p.

A transmission multiplier is described in which electrons release secondaries from the back of a very thin dynode of special construction. Its application as a mass spectrometer detector is discussed. The films used were of evaporated potassium chloride on gold on a film of VYNS. Nine stages were used to give high gain, but the electron beam spread laterally from one dynode to the next. Attempts to overcome this with an applied magnetic field were unsuccessful. Thus simultaneous detection of several masses with single ion detection sensitivity did not prove to be practicable with this device. (auth)

29386 (BLG-57) "TOTAL BODY COUNTER" DU C.E.N. A MOL ETALONNAGE ET OBSERVATIONS SUR 1,500 MESURES. ("Total Body Counter" of the C.E.N. at Mol. Calibration and Observations of 1500 Measurements). R. R. Boulenger, J. F. Colard, and J. Henry (Brussels. Centre d'Etude de l'Energie Nucleaire). May 29, 1961. 17p.

A device for the detection of body burden radioactivity is reported. The measurement is done in a steel shielded room by gamma spectrometry with a NaI crystal 8-in. diameter \times 4-in. height; the subject is placed in a standard position on a chair below the crystal. The method was used for 1500 measurements in routine work or after accidents, and the observed contaminations are discussed. The measurements have shown a noticeable decrease since 2 years of the body burden of Cs^{137} caused by fallout and the amount of natural potassium in the body was measured. (auth)

29387 (CEA-1929) ETALONNAGE D'UN COMPTEUR CLOCHE LCT 13A7 POUR LES MESURES D'ACTIVITE β . (The Calibration of an End-Window Counter LCT 13A7 for the Measurement of β -Activity). Alain Barthoux and Lydie Imbert (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1961. 27p.

The principal corrections to be applied to the end-window type of counter are studied, in the case of flat disc sources containing known or unknown mixtures of radioelements. The region of activity in which this type of counter may be efficiently employed is defined. An experimental curve of the apparent exponential absorption coefficient for β rays in matter is given, thus making possible corrections for autoabsorption and determinations of the apparent energy of the radiation. The error using different counters of the same type is calculated. (auth)

29388 (CTSL-17) A MULTIFOLD COINCIDENCE-VETO CIRCUIT USING TRANSISTORS. Arpad Barna, J. Howard Marshall, and Matthew Sands (California Inst. of Tech., Pasadena. Synchrotron Lab.). Feb. 7, 1961. 37p.

A coincidence-anticoincidence circuit in the 50 nsec time range is described that is capable of being used with large number of counters. Basic considerations affecting the circuit, as well as detailed circuits, operation, and performance, are given. (auth)

29389 (CTSL-18) A 50 NANOSECOND LINEAR GATE CIRCUIT USING TRANSISTORS. Arpad Barna and J. Howard Marshall (California Inst. of Tech., Pasadena. Synchrotron Lab.). Feb. 1961. Contract AT(11-1)-68. 21p.

The circuit described is an improved version of the one developed by Tollestrup. The basic circuit uses two 2N502A transistors in a difference amplifier configuration to provide favorable linearity and feedthrough properties. A proportion of the gating pulse is added to the output to cancel the pedestal, along with a slight positive feedback to reduce the transients. (B.O.G.)

29390 (CTSL-22) SOME TRANSISTOR SMALL SIGNAL EQUIVALENT CIRCUIT CALCULATIONS. Arpad Barna (California Inst. of Tech., Pasadena. Synchrotron Lab.). Mar. 28, 1961. Contract AT(11-1)-68. 29p.

Transient responses, and input and output impedances were derived using a hybrid equivalent circuit. Grounded emitter, base, and collector and emitter degenerated configurations are discussed. (J.R.D.)

29391 (CTSL-23) MEASUREMENT OF SOME TRANSISTOR PARAMETERS. Arpad Barna (California Inst. of Tech., Pasadena. Synchrotron Lab.). Mar. 29, 1961. Contract AT(11-1)-68. 32p.

Collector-to-base capacitance, gain-bandwidth product, beta, and base spreading resistance of several transistors were measured. Test conditions are described and results are presented graphically. (J.R.D.)

29392 (CTSL-27) A DISTRIBUTED AMPLIFIER USING TRANSISTORS. Arpad Barna and J. Howard Marshall (California Inst. of Tech., Pasadena. Synchrotron Lab.). Apr. 28, 1961. Contract AT(11-1)-68. 27p.

A distributed amplifier with a stable gain of 10, risetime of 2.5 nanoseconds for 125 ohm load impedance is described. The maximum output voltage is 3.2 volts with negative polarity. The amplifier consists of 2 stages of 6 Philco 2N1742 transistors each and an emitter follower using a 2N1500. Design formulas were derived and detailed performance of a specific amplifier is given. (auth)

29393 (DEG-Report-327) THE OMEGATRON. P. G. Bentley and J. Leece (United Kingdom Atomic Energy

Authority. Development and Engineering Group, Capenhurst, Ches., England). Dec. 21, 1960. 22p.

Three types of omegatron mass spectrometer were built and tested; no significant differences in operation were detected and the simplest type is recommended for all work. The effects of the ion trapping field were examined and explained; great care is necessary when adjusting this field, particularly for analytical work. The sensitivity of the omegatron is high, and most of the ions formed by electron bombardment can be collected. Some ions, however, are lost because of gas scattering and some because of a different effect which appears at low r-f field strengths. In conditions which allow most of the ions to be collected, the resolution is sufficient to separate adjacent masses at mass 70 to resolve the $H_2^+-D^+$ doublet completely. For leak detection, the minimum detectable leak of helium is 10^{-3} clusecs. For vacuum investigation, vapor pressures down to 2×10^{-11} mm Hg can be measured. Analytical measurements on light-gas samples are limited in precision by gas scattering; the precision attainable (2σ) is 1% at low resolution and 3% at high resolution. (auth)

29394 (DP-608) A STUDY OF THERMAL AND RESONANCE NEUTRON FLUX DETECTORS (thesis). George M. Jacks (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Aug. 1961. Contract AT(07-2)-1. 50p.

Cadmium ratios and self-shielding corrections were obtained for neutron activations of foils of gold, indium, tungsten, europium, manganese, lutetium, and dysprosium in the Standard Pile. Resonance activation integrals were computed by comparison with gold in the following formula, $RI = RI_{Au}(\sigma_{2200}^{act}(Cd R - 1)_{Au} Q_{Au} / (\sigma_{2200}^{act}(Cd R - 1)_{Au} Q_{Au})$, where σ_{2200}^{act} is the activation cross section for 2200 m/sec neutrons. (auth)

29395 (NAA-SR-Memo-4891) FOIL NORMALIZATION. G. W. Rodeback and R. K. Paschall (Atomic International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 21, 1960. 14p.

Reactor activation experiments made with "normalizing" bare In foils in conjunction with a foil holder containing alternate Cd-covered and bare In foils show that the effects of neighboring foil covers on the bare foils in the holder are not always negligible. Flux traverses with two types of single fuel elements gave apparent flux depressions of 4.4 and 0.8% for the horizontal and vertical directions, respectively. (D.L.C.)

29396 (NASA-TN-D-870) A COOLED-TUBE PYROMETER WITH EXPERIMENTAL RESULTS OBTAINED IN A HIGH-TEMPERATURE GAS STREAM. George E. Glawe, Robert C. Johnson, and Lloyd N. Krause (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Aug. 1961. 25p.

An immersion-type pyrometer is described whose primary sensing element is a cylindrical tube in cross flow. The heat-transfer rate to this unit is determined by measurement of the flow rate and temperature rise of a coolant passing through the tube. The heat-transfer rate can then be related to free-stream temperature, after determination of a constant of proportionality by calibration against a reference pyrometer at some convenient lower temperature. Experimental data were obtained in a subsonic exhaust-gas stream over a pressure range of $\frac{2}{3}$ to $1\frac{1}{2}$ atmospheres and a temperature range of 1600 to 4400°R. (auth)

29397 (NP-9575) A FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER WITH APPLICATIONS. Technical Paper No. 176. G. C. Neilson, W. K. Dawson, F. A.

Johnson, and J. T. Sample (Canada. Suffield Experimental Station, Ralston, Alberta). Apr. 11, 1960. 126p.

A versatile neutron time-of-flight spectrometer suitable for use in the millimicrosecond region is described. Either the r-f beam deflection method or the gamma coincidence method is used to provide the zero-time indication. Details of the methods, along with spectra obtained for some (d,n) reactions, are given. The two systems are compatible and make use of the same simple time-to-pulse-height converter. The dependence of the decay time of a liquid scintillator on the specific ionization of the detected particle was used to make the neutron detector insensitive to gamma-rays. (auth)

29398 (NP-10669) GENERATOR FOR PRODUCING HIGH CONCENTRATIONS OF SMALL IONS. Technical Report No. 12. K. T. Whitby, A. R. McFarland, and D. A. Lundgren (Minnesota. Univ., Minneapolis and Public Health Service, Washington, D. C.). July 1960. 58p.

A free ion generator, capable of producing high concentrations of light ions with high efficiency, has been developed. Ions generated in the corona about a needle point are forced through a sonic orifice and thence free of the accelerating field. Positive and negative ion concentrations as high as 10^{11} ions/cm³ in the sonic jet are produced. Ion outputs of 10^{14} /sec using about 2.5 cfm of free air at 30 psig through a $\frac{1}{16}$ inch orifice are achieved. The generator is capable of producing positive, negative or an equal mixture of positive and negative ions. The high ion concentrations decay very rapidly due to space charge and recombination effects. A theoretical and preliminary experimental study of ion decay is made. The ion concentration is found to drop off approximately as the (-2) power of the distance from the generator along the axis of the jet. Concentrations five feet from the ionizer along the jet axis are on the order of 10^6 ions/cm³. (auth)

29399 (NYO-9804) STUDY OF NEGATIVE IONS WITH A CYCLOIDAL INSTRUMENT. Scientific Paper 808-D801-P2. W. J. Lange (Westinghouse Electric Corp. Research Labs., Pittsburgh). July 24, 1961. Contract AT(30-1)-2176. 16p.

Dissociative attachment studies were made for the production of H⁻ and O⁻ ions in the electron bombardment of water vapor with a cycloidal instrument to compare the results with previous data obtained with mass spectrometers and total ionization tubes. The peak heights were studied as a function of spectrometer operating conditions to obtain confidence in the present data with regard to the relative intensities. Graphical representations are included of the results along with a schematic of the apparatus used in the study. (B.O.G.)

29400 (PWAC-339) DEVELOPMENT OF HIGH TEMPERATURE SENSORS, JULY 1, 1959-APRIL 30, 1961. Robert R. Holmes (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). June 30, 1961. Contract AT(11-1)-229. 83p.

Investigation of many high-temperature metals and alloys resulted in the selection of a molybdenum or molybdenum-0.5 titanium element and a niobium or niobium-1 zirconium element for high-temperature reactor thermocouple use. Since this report is a summary of work in process in the evaluation of these wires, it contains some results which are conflicting and unexplained. The preliminary investigation of this thermocouple included calibration and endurance testing of wire obtained from a variety of sources. These tests indicated that a thermocouple made of these wires would have a predictable calibration and would be stable at high temperatures. Since

both molybdenum and molybdenum-0.5 titanium were found to have excellent thermoelectric properties, and pure molybdenum had superior physical properties, pure molybdenum was selected for one element of the thermocouple. Subsequent tests of niobium-1 zirconium indicated that it was not a stable thermoelectric element at high temperature. Since this instability was tentatively attributed to the behavior of the zirconium, pure niobium is recommended for the other element of the thermocouple. The selection of extension leads and insulation for molybdenum/niobium thermocouple is also described. (auth)

29401 (SCTM-151-61(72)) AMT-4 RADISONDE TRANSMITTER MODIFICATION ASSEMBLY (USING THE NEW ALUMINUM-OXIDE HUMIDITY ELEMENT). C. M. Stover (Sandia Corp., Albuquerque, N. Mex.). Sept. 1961. 12p.

A modification to the AMT-4 radiosonde transmitter and modulator which permits the use of a new aluminum oxide humidity element is described. The modification is simple enough to be made by relatively unskilled personnel in the field and involves: using the newly developed aluminum oxide humidity element, slightly modifying the transmitter, and slightly revising the modulator circuitry. The polarization problem usually associated with using humidity elements in a direct-current circuit is also minimized by this modification. (auth)

29402 (TID-7612) PROCEEDINGS OF THE UNIVERSITY OF NEW MEXICO CONFERENCE ON ORGANIC SCINTILLATION DETECTORS, AUGUST 15-17, 1960. Guido H. Daub, ed. (New Mexico. Univ., Albuquerque), F. Newton Hayes and Elizabeth Sullivan, eds. (Los Alamos Scientific Lab., N. Mex.). 417p.

Twenty-three papers are included which were presented at the Conference on Organic Scintillation Detectors. The topics treated range from measurements of organic phosphor properties to liquid and plastic scintillation detectors. Separate abstracts were prepared for each of the papers. (D.L.C.)

29403 (TID-7612(p.12-36)) THE EFFICIENCY OF ORGANIC SCINTILLATORS. J. B. Birks (Manchester. Univ., England. Physical Labs.).

The factors determining the scintillation efficiency of various types of organic scintillators are discussed. Competitive processes in pure crystals and in binary and ternary solutions are considered. (D.L.C.)

29404 (TID-7612(p.37-58)) STUDY OF ENERGY TRANSFER BY QUENCHING EXPERIMENTS. Felix H. Brown, Milton Furst, and Hartmut Kallmann (New York Univ., New York. Solid State Labs.).

The processes by which excitation energy produced in a bulk material can reach a fluorescent solute are discussed, and quenching experiments were made to determine the relative importance of the processes. The experiments were carried out on solutions of 9,10-diphenylanthracene, fluoranthene, m-terphenyl, pyrene, and α -naphthylphenyl-oxazole in various solvents, using carbon tetrachloride and hexachloroxylene as quenchers. Experiments were also conducted on the quenching of solute fluorescence in polyvinyl naphthalene solid by hexachloroxylene and diphenylmercury. The results indicate that, in solutions, quenching decreases with solvent dilution, and in solids, specific orientation between quencher and excited molecule may be necessary. (D.L.C.)

29405 (TID-7612(p.59-76)) ON THE INFLUENCE OF BROWNIAN MOTION ON THE TRANSFER OF ENERGY IN SOLUTIONS. Arye Weinreb (Argonne National Lab., Ill.).

The effects of Brownian motion on the process of energy transfer from an excited solvent to an accepting solute were studied by means of experiments on solutions in paraffin oil, using anthracene as the acceptor and naphthalene, toluene, and anisole as donors. The results are in qualitative agreement with Förster's theory. (D.L.C.)

29406 (TID-7612(p.78-91)) SUBSTITUTED p-OLIGO-PHENYLENES. PART I. SYNTHESIS AND PROPERTIES OF SUBSTITUTED p-OLIGOPHENYLENES. H. O. Wirth (Johannes-Gutenberg-Universität, Mainz. Organisch-Chemisches Institut).

The Ullmann and organometallic carbonyl methods of synthesis of substituted p-oligophenylenes are discussed. The solubility in toluene, melting point, and u-v absorption spectrum of these compounds are also discussed. (D.L.C.)

29407 (TID-7612(p.92-8)) SUBSTITUTED p-OLIGO-PHENYLENES. PART II. SUBSTITUTED p-OLIGO-PHENYLENES AS LIQUID SCINTILLATION SOLUTES. G. Hermann, H. J. Eichhoff, and U. Nay (Johannes-Gutenberg-Universität, Mainz. Anorganisch-Chemisches Institut).

The scintillation properties of substituted p-oligophenylenes were investigated in toluene solvent, and data are given. (D.L.C.)

29408 (TID-7612(p.99-120)) A COMPARATIVE SCINTILLATION STUDY OF SOME SELECTED BIS-BENZOXAZOLE SOLUTES. BENZOXAZOLES III. E. Nyilas and J. L. Pinter (Massachusetts. General Hospital. Physics Research Lab., Boston).

Some tentative proof of an hypothesis is presented concerning the energy absorption and emission mechanism of conjugated bis-benzoxazole solutes. Two series of bis-benzoxazoles were prepared and tested as primary and/or secondary scintillators. A few of the compounds yielded favorable light outputs, and in certain cases the scintillation performance can be directly correlated with corresponding molecular structures. (auth)

29409 (TID-7612(p.121-40)) HEXAFLUOROBENZENE LIQUID SCINTILLATORS AND THEIR APPLICATION TO GAMMA AND FAST NEUTRON DOSE RATE MEASUREMENTS. D. L. Williams (Los Alamos Scientific Lab., N. Mex.).

Because C_6F_6 contains no hydrogen, it can be used as the solvent for a gamma-sensitive liquid scintillator in a paired detector system. Methods for synthesis and purification of C_6F_6 are given. Solutes in C_6F_6 were evaluated as liquid scintillators; 9,10-diphenylanthracene in oxygen-free C_6F_6 is considered to be the best choice for monitoring high gamma dose rates. The design of photovoltaic cell detectors for use with gamma-sensitive scintillators and the calibration of paired detectors are discussed. The factors affecting detector response are discussed in detail. (D.L.C.)

29410 (TID-7612(p.141-60)) SOLID AND LIQUID SOLUTION SCINTILLATORS CONTAINING MONOISOPROPYLBIPHENYL. B. Lionel Funt (Manitoba. Univ., Winnipeg).

Studies were conducted on the scintillation properties of monoisopropylbiphenyl (MIPB) in plastic and liquid scintillators. MIPB was found to be an efficient chain transfer agent in vinyl toluene polymerization. The quenching constants of MIPB as solvent were found to be lower than those for toluene. (D.L.C.)

29411 (TID-7612(p.161-76)) PROGRESS IN PLASTIC SCINTILLATORS. Louis J. Basile (Argonne National Lab., Ill.).

A review of plastic scintillators is presented which treats preparation, luminescent properties, mechanism of energy transfer, and applications of these scintillators. (D.L.C.)

29412 (TID-7612(p.177-95)) THE DEPENDENCE OF PULSE HEIGHT ON THE MOLECULAR STRUCTURE OF THE SOLVENT AND FLUOR IN ORGANIC SCINTILLATORS. Samuel Loshaek and Stanley R. Sandler (Borden Chemical Co. Central Research Lab., Philadelphia).

Studies were conducted to determine the relationship of scintillation efficiency to the Hammett σ value of the fluor for plastic, liquid, and crystalline scintillators. Results are presented for substituted forms of styrene polymers, polyvinyltoluenes, 2,5-diphenyl-1,3-oxazoles, 2,5-diphenyl-1,3,4-oxadiazoles, and benzene crystals in the form of pulse height vs σ curves. The implications of the results are discussed, and a scintillation mechanism is proposed. (D.L.C.)

29413 (TID-7612(p.198-215)) PHOTOMULTIPLIERS FOR THE SCINTILLATION COUNTING OF C^{14} AND TRITIUM. J. Sharpe (E. M. I. Electronics, Ltd., Hayes, Kent, England).

The design, operation, and characteristics of photomultiplier tubes are discussed with respect to counting low-energy beta emitters such as C^{14} and H^3 . (D.L.C.)

29414 (TID-7612(p.216-31)) NEW ACCESSORIES FOR LIQUID SCINTILLATION COUNTING. Edward Rapkin and L. E. Packard (Packard Instrument Co., La Grangé, Ill.).

Three accessories are described for liquid scintillation counting: (1) a polyethylene counting vial which has less background than glass vials, (2) a continuous liquid flow monitor, and (3) a gas chromatography fraction collector for effluent detection. (D.L.C.)

29415 (TID-7612(p.232-8)) SOME RECENT DEVELOPMENTS IN LIQUID SCINTILLATION COUNTING OF BIO-CHEMICAL SAMPLES. Jack D. Davidson (National Cancer Inst., Bethesda, Md.).

A brief review is presented on a few techniques recently developed for applying liquid scintillation counting to the assay of beta emitters used in biochemical research. Some of the topics covered are gelled suspensions, solvent mixtures, counting of aqueous samples, and counting of activities deposited on filter paper. (D.L.C.)

29416 (TID-7612(p.260-75)) CORRECTION FOR QUENCHING IN LIQUID SCINTILLATION COUNTING OF HOMOGENEOUS SAMPLES. C. T. Peng (California. Univ., San Francisco. Medical Center).

The internal standard and extrapolation methods of correcting for quenching are compared. The precision of each method was studied under various quenching conditions with samples containing C^{14} -labeled succinic acid and tritiated methyl stearate and a Tri-Carb liquid scintillation spectrometer. Both methods were found to be equally accurate under conditions of minimal quenching or dilute sample concentration. (D.L.C.)

29417 (TID-7612(p.278-85)) LANDSTUHL 2π HUMAN COUNTER. 1. MEASUREMENT OF CESIUM-137 AND POTASSIUM. Charles O. Onstead (Army Medical Research Unit No. 1, Landstuhl Army Medical Center, Germany).

The 2π liquid scintillation counter designed for measuring the Cs^{137} and K^{40} contents in people is described, and calibration curves of counting efficiency vs weight are given for various heights. Graphs are presented for the K and Cs^{137} contents of a large number of German people. (D.L.C.)

29418 (TID-7612(p.286-92)) MEASUREMENT OF CONTAMINATED INDIVIDUALS. Erich Oberhausen (Saar. Universität, Homburg, Germany. Biophysikalisches Institut).

Results are described for experiments in which a human counter was used to study and separate the gamma spectra of various individuals exposed to radioisotopes. Some individuals had unusual activities which are suspected to be due to administration of thorotrast medicine in the past. (D.L.C.)

29419 (TID-7612(p.293-311)) MEASUREMENTS OBTAINED WITH THE 2π LARGE VOLUME COUNTER (GENCO) AND THEIR COMPARISON WITH THE RESULTS OBTAINED FROM OTHER PHYSICAL OR CHEMICAL METHODS. Alexander A. Pfau and Georg Kallistratos (Max-Planck-Institut für Tierzucht und Tierernährung, Mariensee, Germany).

The geometrical problem of using the 2π Landstuhl large-volume counter was studied by analysis of hams for their K^{40} contents. The problems imposed by fission product contamination in the counting of foodstuffs was studied. The behavior of the counter for activities higher than 10^{-7} c Cs^{137} was determined. (D.L.C.)

29420 (TID-7612(p.329-43)) THE PERFORMANCE OF LARGE-VOLUME PLASTIC SCINTILLATORS WITH REFERENCE TO WHOLE BODY COUNTING. P. R. J. Burch (Leeds, England. Univ.).

The factors affecting the resolution of large plastic scintillators used for gamma-ray detection are discussed, and it is shown that the pulse height observed for a given event depends on its position in the scintillator. Light guides and scintillator thickness are discussed. Preliminary counting statistics are presented for a 3-unit plastic scintillator apparatus. (D.L.C.)

29421 (TID-7612(p.344-70)) THE NEW LOS ALAMOS HUMAN COUNTER: HUMCO II. E. C. Anderson, R. L. Schuch, and V. N. Kerr (Los Alamos Scientific Lab., N. Mex.).

A new 4π liquid scintillation counter for the measurement of low-level gamma activity in human subjects was constructed. A counting well 18 in. diam. by 6 ft long is surrounded by a layer of liquid scintillator 12 in. thick. Scintillator volume is 450 gal, and 24 multiplier phototubes provide a cathode-to-total-wall-area ratio of 0.24. Six single channel analyzers cover the energy range 0.1 to 3 Mev. Electronic circuits are completely transistorized, and all data are automatically transcribed on punched cards. A nonvolatile solvent will be used to eliminate fire hazards. Operating characteristics, including energy resolution and sensitivity, are reported. (auth)

29422 (TID-7612(p.371-94)) RECENT SCINTILLATION CHAMBER RESEARCH. G. T. Reynolds, D. B. Scarl, and R. A. Swanson (Princeton Univ., N. J.).

Techniques developed for scintillation chambers are reviewed. The principal topics treated are image intensifier developments, filament scintillators, and tracks of π^{\pm} mesons. (D.L.C.)

29423 (TID-7612(p.395-404)) APPLICATIONS OF GIANT SCINTILLATION DETECTORS. Frederick Reines (Case Inst. of Tech., Cleveland).

Some of the possible uses of very large scintillation detectors are low- and high-energy neutrino studies, cosmic ray neutrino studies, and anticoincidence applications. (D.L.C.)

29424 (TID-13065) BASIC RADIATION STUDIES. Quarterly Progress Reports for the Period November 1960

thru April 1961. William H. Johnston (Johnston (William H.) Labs., Inc., Baltimore). Contract AT(11-1)-650. 52p.

Current experimental studies consist of the application of the coincidence mass spectrometer to a research of primary fast metastable radiation species, and on primary multiple ionization phenomena. Theoretical studies are associated with the plan and interpretation of these measurements, and includes a continuing review of the world literature and the analyses of potentially feasible radiation chemistry processes. The radiation synthesis of hydrazine from ammonia is analyzed. (B.O.G.)

29425 (TID-13490) MEASUREMENT OF L/K-CAPTURE RATIOS IN ELECTRON-CAPTURING NUCLIDES. (thesis). Augusto Galvez Santos Ocampo (Purdue Univ., Lafayette, Ind.). Jan. 1961. Contract AT(11-1)-694. 117p.

The design and construction of a high-pressure multi-wire gas proportional counter are described. The counter is designed such that no electron capture (EC) event is recorded if the K_{α} x ray escapes the counter chamber. Using the counter, values of 0.103 ± 0.003 and 0.119 ± 0.007 are found for the L/K EC ratios of Ar^{37} and Zn^{65} , respectively. (T.F.H.)

29426 (VDIT-32(2)) DETECTORS FOR NEUTRON AND GAMMA RADIATION. PART II. (A LITERATURE SURVEY). Wolfram Uhlmann (Aktiebolaget Atomenergi, Stockholm). Mar. 1961. 121p.

A comprehensive but not exhaustive survey of the literature is given. Books are not listed. The survey comprises 417 abstracts. (J.R.D.)

29427 (AEC-tr-4785) ELECTRODELESS MEASUREMENT OF ELECTRICAL CONDUCTIVITY USING THE ROTATING FIELD METHOD. Albert Roll, Hans Felger, and Hasso Motz. Translated for Los Alamos Scientific Lab. from Z. Metallk., 47: 707-13(1956). 12p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13; abstract no. 12791.

29428 (AEC-tr-4807) SOME BASIC PRINCIPLES AND CONDITIONS OF MEASUREMENT TECHNOLOGY. Franz Moeller. Translated for Oak Ridge National Lab., Tenn. from VDI Zeitschrift, 103: 869-74(1961). 25p. (Includes original, 6p.).

A review of especially important basic principles and other fundamentals is presented. A discussion is given of accuracy concepts and the requirements for accuracy with respect to the measuring instruments themselves and their installation, measuring sensitivity, damping, and the frequency curve of test instruments including the principle of self-balance in bridges and compensators. (J.R.D.)

29429 (CEA-tr-R-1218) MESURES DE LA RADIO-ACTIVITÉ DES GAZ ET DES AÉROSOLS. (Measurements of the Radioactivity of Gases and Aerosols). K. K. Aglintsev. Translated into French from "Dozimetriya Ioniziruyushchikh Izluchenii" (A publication of the State Publishing House of Technical-Theoretical Literature, Moscow, 1957). 10p.

Some methods and the necessary apparatus for the measurement of the radioactivity of gases and aerosols are briefly described. A fast ionization chamber for measuring the α activity of atmospheric air is first considered. The basic principle of measurements on aerosols is precipitation from a given volume of air and measurement of the resulting activity on the precipitating surface. The principle of two apparatus designed for such measurements is given. Ionization chambers or Geiger counters

can be used for the measurement of air activity. The parameters of a differential chamber designed for air measurements are indicated. (J.S.R.)

29430 (JPRS-8791) CZECHOSLOVAK REPORT ON MINIATURE ELECTRON TUBES. Translation of excerpts from p.133-44; 151-62; 222-6 of "Ceskoslovenske Miniaturni Elektronky." [nd.]. 35p.

A double triode, type 6CC31, which can be used at very high frequencies is described and compared to similar types. Uses of the tube as an amplifier, mixer, power oscillator, beat oscillator and indicator of signal level, oscillator for a vertical resolution generator, and in a multivibrator are discussed. Its electric characteristics are outlined. Tesla tube 6F31 which is an hf pentode with an exponential course of characteristics is described. Its uses in radio receivers and oscillator frequency changers are discussed. Tesla tube 6F32 which is a linear hf pentode with a considerable steepness is also described. Its uses as a wide-band amplifier with very small noise, wide-band interfrequency amplifier, oscillating mixer, low-frequency amplifier of voltage, and correction amplifier of a tape recorder are outlined. Its electrical characteristics are summarized. A similar tube type 6F33 intended for use with high frequencies is described and compared with other types. (M.C.G.)

29431 A β -SPECTROMETER WITH A LONGITUDINAL AND HOMOGENEOUS FIELD. A. Gelberg, I. Negrescu, and I. Ringhiopol (Inst. of Atomic Physics, Bucharest). Acad. rep. populare Romine, Inst. fiz. atomică și Inst. fiz., Studii cercetări fiz., 11: 1041-7(1960). (In Rumanian)

On the basis of currently available technology, the resolving power of a β -spectrometer can be increased only at the expense of the luminosity of the instrument. This difficulty was eliminated by constructing an apparatus provided with a homogeneous longitudinal field, partially compensating for spheric aberrations. A transversal magnetic field, the intensity of which is inversely proportional to its distance from the symmetry axis of the instrument, was superimposed on the homogeneous longitudinal field in the region of the largest number of electron trajectories, following the data given by K. A. Dolmatova and V. M. Kel'man (Doklady Akad. Nauk SSSR 113: 6 (1957)). This field is generated by a toroidal coil. The characteristics of the instrument were determined by means of a G-M counter filled with isopentane and argon and provided with a 4.08-mg/cm² cellophane window which allows passage of electrons with energies above 60 kev into the counter. Au¹⁹⁸ and In¹¹⁴ sources were used for the study. The theoretical transmission of the instrument was 8.2%. (TTT)

29432 THIMBLE CHAMBER CORRECTIONS BELOW 100 KV. EFFECTIVE. James C. Carlson (Hackley Hospital, Muskegon, Mich.). Am. J. Roentgenol., Radium Therapy Nuclear Med., 86: 737-9(Oct. 1961).

Existing data are presented in a more utilitarian form and attention is brought to the necessity of correcting r-chamber measurements in the calibration of output from superficial roentgen therapy apparatus. These corrections, when properly applied, should improve the specification of dosage. (auth)

29433 PHOTOPeAK COUNTING EFFICIENCIES FOR 3 x 3 INCH SOLID AND WELL-TYPE NaI SCINTILLATION CRYSTALS. Ray Gunnink and A. W. Stoner (United States Rubber Co., at Industrial Reactor Labs., Inc., Plainboro, N. J.). Anal. Chem., 33: 1311-13(Sept. 1961).

Using 4 π and 4 $\pi\beta$ - γ coincidence standardization techniques, a 3 x 3 inch well-type and a 3 x 3 inch solid NaI(Tl) crystal were calibrated for photoppeak counting efficiency.

With these efficiencies, NaI(Tl) crystals of these sizes may be used to determine quantitatively the gamma disintegration rate of radioactive isotopes. (auth)

29434 COUNTING STATISTICS FOR LIQUID SCINTILLATION COUNTING. R. J. Herberg (Lilly Research Labs. Indianapolis). Anal. Phys., 33: 1308-11(Sept. 1961).

The way in which the errors associated with individual countings of a sample by liquid scintillation techniques are compounded in the calculation of a net disintegration rate was investigated. The standard deviation of rates calculated from duplicate samples is compared with the standard deviation calculated from a propagation of error equation. At the 5% significance level the experimental and theoretical standard deviations agree. The usefulness of the propagation of error equation is explained. (auth)

29435 THE MEASUREMENT OF THE TIME DISTRIBUTION OF γ -RADIATION IN WOOD BY THE METHOD OF DELAYED COINCIDENCES. A. I. Veretennikov, V. Ya. Averchenkov, and M. V. Savin. Atomnaya Energ., 11: 177-80(Aug. 1961). (In Russian)

A 0.12 mc Co⁶⁰ source was embedded in a pine block 3.4 x 4 x 1 m³. Detector 1 picked up the γ -quanta of Co⁶⁰ and fed the electrical impulse to a time analyzer with a resolving time of 2.3 nanoseconds. Detector 2 placed at a distance of 200 cm from the source was connected in coincidence with Detector 1. Detector 2 picked up the delayed impulse of the 1.25-Mev γ -quanta. The difference in time of arrival between the two impulses gives the build-up of intensity of the γ -radiation in wood due to multiple scattering of the γ -quanta. The time distribution of the γ -radiation in wood at a distance of 200 cm from the point source was about 20 nanoseconds. The maximum of the intensity of the time distribution is shifted with respect to zero time by ~1.6 nanoseconds. This corresponds to an increase in path length of the γ -quanta by a factor of ~1.5 of the mean free path. The average delay time of the γ -radiation was about 6 nanoseconds. The half-width of the time distribution was equal to 7 nanoseconds. The build-up factor turned out to be equal to 10.4 for γ -quanta having an energy greater than 50 kev. (TTT)

29436 MEASUREMENT OF ARTIFICIAL RADIOELEMENTS. I. THE LABORATORY FOR THE MEASUREMENT OF RADIOELEMENTS. B. Grinberg. Bull. inform. sci. et tech. (Paris), No. 51, 86-8(May 1961). (In French)

The general program of the laboratory is outlined and described in some detail. (J.S.R.)

29437 [MEASUREMENT OF ARTIFICIAL RADIOELEMENTS]. II. MEASUREMENT OF THE ACTIVITY OF RADIATION EMITTERS. 1. MEASUREMENT OF THE ACTIVITY OF BETA EMITTERS. B. Grinberg. Bull. inform. sci. et tech. (Paris), No. 51, 89-91(May 1961). (In French)

For the measurement of the activity of β emitters various types of installations are used either for a given type of measurement or for activities of a given order. The types of installations used are briefly described. (J.S.R.)

29438 [MEASUREMENT OF ARTIFICIAL RADIOELEMENTS]. II. MEASUREMENT OF THE ACTIVITY OF RADIATION EMITTERS. 2. MEASUREMENT OF ALPHA-EMITTING SOURCES. J. J. Engelmann and A. Capgras. Bull. inform. sci. et tech. (Paris), No. 51, 91-5(May 1961). (In French)

For α sources there is often the problem of determining, sometimes simultaneously, both the source activity and the spectral distribution of the α emitted. In the Laboratory for the Measurement of Artificial Radioelements ionization chambers are generally utilized. The characteristics of

several types of ionization chambers are given, and the methods used for α measurements are discussed. (J.S.R.)

29439 [MEASUREMENT OF ARTIFICIAL RADIOELEMENTS]. II. MEASUREMENT OF THE ACTIVITY OF RADIATION EMITTERS. 3. IONIZATION CHAMBERS FOR MEASUREMENTS OF THE ACTIVITY OF GAMMA EMITTERS. J. J. Engelmann and J. Vagner. *Bull. inform. sci. et tech.* (Paris), No. 51, 96-100 (May 1961). (In French)

The design and characteristics of well ionization chambers (4π γ chambers) are discussed. The advantages and disadvantages of this instrument are reviewed. A γ chamber of the Bragg-Gray type, which does not have the disadvantages of the well chamber, is described. (J.S.R.)

29440 MEASUREMENT OF ARTIFICIAL RADIOELEMENTS. II. MEASUREMENT OF THE ACTIVITY OF RADIATION EMITTERS. 4. MEASUREMENTS OF LOW LEVEL ACTIVITY. Y. Le Gallic. *Bull. inform. sci. et tech.* (Paris), No. 51, 101-4 (May 1961). (In French)

In the measurement of low-level activity (10^{-6} to 10^{-8} $\mu\text{C/g}$) it is necessary to reduce the cosmic radiation, the contamination of the materials used, and the ambient radiation of the laboratory. The essential characteristics of a laboratory for the measurement of low-level activities are briefly described. (J.S.R.)

29441 THE APPLICATION OF A FLUXGATE MAGNETOMETER TO AN AUTOMATIC ELECTRONIC DEGAUSSING SYSTEM. R. L. Graham and J. S. Geiger (Atomic Energy of Canada Ltd., Chalk River, Ont.). *Can. J. Phys.*, 39: 1357-68 (Sept. 1961). (AECL-1315)

The three-component fluxgate magnetometer developed by Serson is adapted to provide continuous correction signals to the degaussing system of the Chalk River iron-free β -ray spectrometer. Improved electronic circuitry is developed for the magnetometer which minimizes the zero error and reduces to $<10^{-4}$ gauss long-term drift caused by component aging. The degaussing coil arrangement used to generate uniform magnetic field components opposite to those of the earth is indicated and the current regulation system is described briefly. The method in which the magnetometer correction signal is introduced into the current regulators is shown and an example is given of the performance of this degaussing system during a magnetic storm. (auth)

29442 HOW MAGNETIC MATERIALS BEHAVE AT NANOSECOND PULSE WIDTHS. Gilbert A. Reeser (Univ of California, Livermore). *Electronics*, 34: No. 36, 72-5 (Sept. 8, 1961).

Tape wound and ferrite cores were tested for operation at 30-nanosecond pulse width. Data are extrapolated to large cores for 0.1 megawatt operation. Diagrams of equipment are presented, and wave forms and data are given. Multimegawatt pulses at megacycle rates are visualized. (L.N.N.)

29443 AN OBJECTIVE METHOD OF RECORDING THE ENERGY SPECTRA OF ELECTRONS FOR AN ELECTROSTATIC ANALYZER. A. N. Kabanov, Yu. M. Kushnir, and D. V. Fetisov. *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 748-51 (June 1961). (In Russian)

In an electrostatic analyzer it is desirable to keep the optimum focusing distance R_{opt} constant to keep the resolution at a maximum and to avoid changes in the intensity of the electrons recorded from a change in the optical power of the analyzing lens. These difficulties are avoided by introducing a second slit on the exit side of the analyzer so that only electrons of optimum energy can go through the second slit. The optimum focusing distance R_{opt} is main-

tained constant by varying the potential on the analyzing lens. An electron beam with a small energy dispersion enters the first slit of the analyzer. Then, on establishing the optimum mode of operation for the elastically scattered electrons, varying the electrode potential and measuring the number of electrons going through the second slit each time, it is easy to obtain information on the energy losses of the electrons and on the line intensities in the spectrum. The unit is considerably simplified by adding a semi-transparent fluorescent screen, a photoelectron multiplier and a self-recording potentiometer to record the intensity of the electron beam. (TTT)

29444 THE USE OF AN ELECTRON ANALYZER IN STUDYING THE ENERGY COMPOSITION OF ELECTRONS REFLECTED FROM A METAL. Yu. M. Kushnir and A. N. Kabanov. *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 752-3 (June 1961). (In Russian)

Measurements of the energy losses of 70-keV electrons reflected from various metals were studied on an electrostatic analyzer which gave the energies and intensities of the emergent electron beam. A fluorescent screen, photo-multiplier and self-recording potentiometer were used to record the energy spectra of the electrons. The pressure in the analyzer was about 1×10^{-5} mm Hg std. The glancing angle was kept constant at 4° in all experiments. The objective was a disk 3 to 4 mm wide and 0.08 to 0.10 mm thick. This disk could be heated with direct current up to 1000°C so that the characteristic energy losses of the reflected electrons could be measured at various temperatures. The energy losses of the electrons determined by this method agree with the values obtained by using the photographic method of recording the electron energies and intensities. (TTT)

29445 THE MECHANISM OF THE OPERATION OF A PROPORTIONAL COUNTER. G. A. Korolev and G. E. Kocharov (Ioffe Inst. of Physics and Tech., Academy of Sciences, USSR). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 866-70 (July 1961). (In Russian)

A natural mixture of uranium isotopes was used to study the resolution of a 28-channel proportional counter operating at a pressure of 1.3 to 1.5 atm with a mixture of argon and methane. The counter was carefully constructed to eliminate voltage instability, end effects, and noise background. The gaseous amplification factor A, which depends on the gas pressure, type of gas, and the geometry of the counter, was measured from the change in the amplification factor of the amplifier. In mixtures of argon and methane, the gaseous amplification factor A decreases with the addition of 6% or more of methane to the argon, as compared to the value of A in pure argon. However, at small concentrations of methane impurity ($<6\%$), the gaseous amplification factor A does not decrease, but rather increases. It is pointed out that an increase in gaseous amplification factor A is possible in all cases where the ionization potential of the impurity is less than the excitation energy of the main gas. Hence, the theory of Rose and Korff is not valid for gaseous mixtures where there is a possibility of forming additional electrons due to secondary collisions between excited atoms of the noble gas (argon) and molecules of the impurity (methane). (TTT)

29446 ON HUMAN COUNTER. T. Aoki (Japan Atomic Energy Research Inst., Tokyo). *J. At. Energy Soc. Japan*, 3: 560-9 (July 1961). (In Japanese)

Descriptions and illustrations are given of various counters. The sensitivity and usefulness of the counters are given along with data obtained on English, U.S., and other foreign subjects. (P.C.H.)

29447 A MASS SPECTROMETER FOR IONIZATION EFFICIENCY STUDIES USING AN ELECTRON VELOCITY SELECTOR. P. Marmet and J. D. Morrison (C.S.I.R.O., Melbourne). *J. Chem. Phys.*, 35: 746-7 (Aug. 1961).

Ion efficiency curves are studied using a mass spectrometer. Information regarding the upper-energy states of atoms and molecules is thus obtained. The required beam of ionizing particles, homogeneous and continuously controllable in energy, is provided through an electron velocity selector built into the mass spectrometer. A description of the apparatus and direct ionization efficiency curves for neon and argon are given. (L.N.N.)

29448 STUDY OF THE CHARACTERISTICS OF 54 AVP PHOTOMULTIPLIERS WITH RESPECT TO THEIR UTILIZATION IN A DETECTOR FOR RADIATIVE CAPTURE γ RAYS. P. Ribon, A. Coin, A. Michaudon, and H. Nifenecker (Centre d'Etudes Nucleaires, Saclay, France). *J. phys. radium*, 22: Suppl. to No. 6, 108A-14A (June 1961). (In French)

Some neutron cross sections measured with the Saclay linear accelerator as a neutron spectrometer are obtained by means of a capture γ -ray detector. The operating characteristics of the 54 AVP photomultiplier tubes used in this detector were studied with reference to resolution and gain stability in connection with counting rate, temperature, and fatigue effect. A 10% resolution of the 660 keV γ of Cs^{137} can be obtained. The lack of photocathode homogeneity appears to be the main obstacle to a better result. The gain shift in terms of the anode current is calculated and compared with experiments. The fatigue effect is shown. The gain variation relative to a temperature change is studied both theoretically and experimentally, taking into account the crystal decay time and the anode integration time constant. (auth)

29449 A SIMPLE LACUNOMETER FOR THE STUDY OF TRACKS IN NUCLEAR EMULSIONS. M. Dellagi (Faculté des Sciences, Strasbourg). *J. phys. radium*, 22: Suppl. to No. 6, 133A-7A (June 1961). (In French)

The simple apparatus described here measures the total length L of gaps as a function of particle range R in nuclear emulsion. The plate moves with constant speed parallel to a fixed direction; the measure of a length becomes a measure of a time, which is carried out by a chronometer photographed at constant interval of time by cinephotography. From the series of negatives obtained, the curve of L as a function of R can be drawn. Applications for 10 pions and one K meson (range: 700 μ) is given. The probability that the average value of M_π/M_K lies in the interval 0.257 to 0.295 is 0.95 (expected value for M_π/M_K is 0.283). This apparatus can be used for tracks as short as 210 μ . (auth)

29450 PRODUCTION OF LIGHT PULSES OF NANO-SECOND RISE TIME AND DURATION BY MEANS OF GAS-DISCHARGE TUBES. Zs. Náray and P. Varga (Central Research Inst. of Physics, Budapest). *J. Sci. Instr.*, 38: 352-4 (Sept. 1961).

Short light pulses of rise time 3×10^{-9} s can be produced by a simple circuit arrangement containing commercially available gas-discharge tubes (thyatron tubes type 2050, voltage-stabilizer tubes type VR150). These pulses are of sufficient intensity to be displayed directly on cathode-ray tubes, using high-gain photomultipliers, without the help of amplifiers. (auth)

29451 IONIZATION GAUGE POWER SUPPLY FOR USE IN A PULSED MAGNETIC FIELD. G. A. Doran (Birmingham Univ., Eng.). *J. Sci. Instr.*, 38: 355-6 (Sept. 1961).

An audio-frequency power supply for the filament of an ionization gage is described. The frequency chosen is

higher than the natural frequency of oscillation of the filament, hence the gage may be used in a magnetic field. Stabilization is achieved by comparing the potential at one end of a high-stability resistance through which the emission current is flowing with a reference potential, and controlling the filament current from the difference of the two. Stability over several weeks of continuous working and over a pressure range of 10^{-3} to 10^{-6} mm Hg is better than 1%. (auth)

29452 EMISSION CONTROL FOR THE OMEGATRON-TYPE MASS SPECTROMETER. G. R. Giedd and G. C. Roberts (IBM Command Control Center, New York). *J. Sci. Instr.*, 38: 361-2 (Sept. 1961).

A circuit of the type used for emission regulation of ion gages is modified to provide closed loop feedback control of omegatron filament emission. Use of this circuit, which monitors and controls the target current, results in emission control of $\pm 3\%$ and reduces long term electrometer zero drift to $\pm 5\%$. (auth)

29453 β AND γ RADIATION DOSIMETRY BY ULTRASONIC EXTINCTION OF IRRADIATED CRYSTAL PHOSPHORS. M. Frank and L. Herforth (Institut für Angewandte Radioaktivität, Leipzig). *Kernenergie*, 4: 435-9 (June 1961). (In German)

Dose measurements for β and γ radiation can be carried out by the extinction of irradiated crystal phosphors with ultrasonics. The sensitivity of the method is several mrad or mr. There is a proportionality between the extinguished light sum and the dose in the air at the irradiation site. Experiments for testing the energy dependence were made. (tr-auth)

29454 AN AUTORADIOGRAPHIC EFFECT. Stuart McLean (General Electric Co., Cleveland). *Nature*, 191: 690-2 (Aug. 12, 1961).

Radioautographic effects were observed from many ordinary substances or mixtures of them. Results are reported from a series of experiments performed to determine the effect on radioautograms of such factors as ambient temperature, transfer of radiation, range of radiation, and life of the radiating bodies. Eastman no-screen x-ray films were used. Results are discussed. (C.H.)

29455 ON RESOLUTION AND LUMINOSITY OF A NEUTRON DIFFRACTION SPECTROMETER FOR SINGLE CRYSTAL ANALYSIS. G. Caglioti, A. Paoletti, F. P. Ricci (Comitato Nazionale per le Ricerche Nucleari, Rome). *Nuclear Instr. & Methods*, 9: 195-8 (Nov. 1960). (CNEN-55). (In English)

Criteria for the choice of the collimators for a crystal spectrometer for neutron diffraction are established in order to achieve a good compromise between luminosity and resolution. General expressions for the full width at half maximum and for the luminosity of the diffraction peaks are developed for single crystal samples. (auth)

29456 TRANSISTORIZED d-c AMPLIFIERS FOR NUCLEAR MEASUREMENTS. R. Gariod (Centre d'Etudes Nucleaires, Grenoble, France). *Onde elec.*, 40: 823-30 (Nov. 1960). (In French)

Nuclear measurements for which transistorized d-c amplifiers were studied were linear measurement of weak currents, logarithmic measurement of weak currents, and differentiation and integration of electrical magnitudes. Direct-coupled and counter-reaction amplifiers are first discussed. Schematics for tube amplifiers and transistorized amplifiers are given, and various applications of transistorized amplifiers are reviewed. (J.S.R.)

29457 PROTON POLARIMETER WITH LOW NEUTRON AND γ BACKGROUND SENSITIVITY. A. K. Val'ter, A. P.

Klyucharev, and N. A. Skakun (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 20-2 (Jan.-Feb. 1961). (In Russian)

A device is described for measuring the polarization of low and mean energy protons. Due to the coincidence scheme, neutron and γ background are at a minimum. (tr-auth)

29458 HIGH-FREQUENCY ION SOURCE WITH DISCHARGE IN SALT VAPORS. V. F. Kozlov, V. L. Marchenko, and Ya. M. Fogel (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 25-8 (Jan.-Feb. 1961). (In Russian)

The design and performance of an ion source for salt vapor discharge is described. Ion currents of ~ 1 ma were developed. Under optimum conditions the ion beam contains up to 90% metal ions. The mean life of the source is 50 hours, the mean consumption is 30 mg/hr. (tr-auth)

29459 GAS CHERENKOV THRESHOLD DETECTORS OPERATING WITH ACCELERATORS. A. N. Belyakov, A. S. Vovenko, A. D. Kirillov, B. A. Kulakov, A. L. Lyubimov, Yu. A. Matulenko, and I. A. Savin (Joint Inst. for Nuclear Research, Dubna, USSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 32-5 (Jan.-Feb. 1961). (In Russian)

The construction and characteristics of two gas threshold Cherenkov detectors are described. One detector was used for separating rare particles in the presence of a large background of other particles, and the other was used for working with synchrotron beams of π and K mesons. The tests indicate the feasibility of separating rare particles from a large background of slower particles. (R.V.J.)

29460 LIQUID HYDROGEN BUBBLE CHAMBER 25 cm IN DIAMETER. M. S. Ainutdinov, S. M. Zombrovskii, J. Ya. Nikitin, and Ya. M. Selektor. *Pribery i Tekh. Ekspt.*, 6: No. 1, 35-9 (Jan.-Feb. 1961). (In Russian)

The design and characteristics are given of a 25-cm diameter, 10-cm deep hydrogen bubble chamber. (tr-auth)

29461 CONTROLLED SPARK CHAMBER-A NEW DEVICE FOR CHARGED PARTICLE TRACK DETECTION. V. A. Mikhailov, V. N. Roinishvili, and G. E. Chikovani (Inst. of Physics, Academy of Sciences, Georgian SSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 39-42 (Jan.-Feb. 1961). (In Russian)

Descriptions are given of a spark device operated on a principle similar to the spark counter. In contrast to the latter the spark chamber is a pulse supplied device. The efficiency of the chamber is studied as a function of time delay and high-voltage pulse amplitude. The precision for charged particle trajectory coordinates and angular distribution is evaluated. (tr-auth)

29462 PARTICLE CHARGE IDENTIFICATION IN PHOTO EMULSION. I. M. Gramenitskii, Z. Korbel, and L. Rob (Joint Inst. for Nuclear Research, Dubna, USSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 42-4 (Jan.-Feb. 1961). (In Russian)

Magnetic deflections of secondary charged particles were measured in an emulsion stack irradiated by a 9-Bev synchrotron proton beam. The feasibility of statistical charge separation is established. (tr-auth)

29463 A DEVICE FOR IDENTIFYING MULTICHARGED PARTICLES STOPPING IN NUCLEAR PHOTOEMULSION. A. P. Zhdanov and I. M. Kuks (Radium Inst., Academy of Sciences, USSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 45-7 (Jan.-Feb. 1961). (In Russian)

The design is given of a photoelectron device for measuring the width of charged particle tracks in emulsions. The track width is measured by an automatic digital read-

out system and does not depend on optical conditions. The order of error does not exceed 2%. Measurements of track width at 30 points can be accomplished within 15 min. (tr-auth)

29464 ON THE THEORY OF CORONA DISCHARGE IN NUCLEAR EMISSION COUNTERS. V. Ya. Savel'ev and Yu. O. Noskov. *Pribery i Tekh. Ekspt.*, 6: No. 1, 47-50 (Jan.-Feb. 1961). (In Russian)

The theory of corona discharge in counters, based on elementary processes in the counter, is discussed. Relations are developed for corona ignition potential and corona current as functions of outer circuit parameters and cathode material. Data for experimentally verifying the theory are quoted. (tr-auth)

29465 GAS DISCHARGE DETECTOR WITH LOGARITHMIC SENSITIVITY FOR RADIATION. Yu. M. Tolchenov and V. G. Chaikovskii. *Pribery i Tekh. Ekspt.*, 6: No. 1, 51-2 (Jan.-Feb. 1961). (In Russian)

A simple method of measuring γ flux by means of corona counters is described. The counter exhibits logarithmic sensitivity to γ emission. The limits are 10^{-2} to 10^6 r/h. The parameters of corona counters for recording γ radiation and operational details are given. (R.V.J.)

29466 USE OF SECTIONAL IONIZATION CHAMBERS FOR ABSOLUTE MONITORING OF HIGH-ENERGY OF RADIATION. I. N. Usova (Inst. of Physics, Academy of Sciences, USSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 53-5 (Jan.-Feb. 1961). (In Russian)

The application of sectional ionization chambers for absolute measurements of high-energy γ emission, utilizing the difference in the number of electron-positron pairs produced, is described. The absolute accuracy of the measurements is higher than that obtained by circular plane-parallel ionization chambers. Measurements of the synchrotron intensity (with $W_{\max} = 260$ Mev) carried out with a sectional chamber are in good agreement with the results obtained by others. (tr-auth)

29467 GAMMA COMPENSATED BF_3 CHAMBER. A. B. Dmitriev and M. G. Vorob'ev. *Pribery i Tekh. Ekspt.*, 6: No. 1, 55-7 (Jan.-Feb. 1961). (In Russian)

The construction and parameters of a BF_3 γ -background compensated chamber are described. The sensitivity of the differentiating chamber for thermal neutrons is 5×10^{-13} a/n/cm² · sec. The chamber sensitivity to γ radiation is reduced to zero within the accuracy of the measurements. (R.V.J.)

29468 SCINTILLATION α DETECTOR WITH THIN FRONT WINDOW. A. V. Elpidinskii and I. N. Fetisov (Inst. of Physics, Academy of Sciences, USSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 57-60 (Jan.-Feb. 1961). (In Russian)

The construction of a portable detector for measuring α activities is described. (tr-auth)

29469 SCINTILLATION GAS DETECTOR FOR RECORDING FISSION PRODUCTS. V. F. Gerasimov. *Pribery i Tekh. Ekspt.*, 6: No. 1, 61-4 (Jan.-Feb. 1961). (In Russian)

Descriptions are given of the design and characteristics of a scintillation gas detector for recording fission product activities against a 3×10^8 α -particle background. The detector was used in determining the cross sections of Am^{241} fission by monoenergetic neutrons of 0.004 to 0.4 ev. (tr-auth)

29470 MEASUREMENTS OF PLASTIC SCINTILLATOR LIGHT YIELDS. A. D. Zaitseva and Yu. N. Panov (Inst. of High-Molecular Compounds, Academy of Sciences,

USSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 64-7 (Jan.-Feb. 1961). (In Russian)

Scintillation light yield was studied in specimens of various size excited by various sources. The performance of plastic scintillators under γ and β excitation was analyzed. (R.V.J.)

29471 LAMINAR SCINTILLATION COUNTER FOR FAST NEUTRONS IN PRESENCE OF γ -QUANTA. V. S. Evseev, V. I. Komarov, V. Z. Kush, V. S. Roganov, V. A. Chernogorova, and M. M. Shimchak (Joint Inst. for Nuclear Research, Dubna, USSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 68-72 (Jan.-Feb. 1961). (In Russian)

The design and performance of a laminar highly efficient ($\sim 10\%$) detector for recording fast neutrons in the presence of a background is described. The detector is capable of recording neutrons with energies of 5 to 20 Mev. (tr-auth)

29472 SCINTILLATION PULSES FROM CsI(Tl) CRYSTALS. G. N. Belozerskii, K. A. Gridnev, and A. N. Pisarevskii (Radium Inst., Academy of Sciences, USSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 73 (Jan.-Feb. 1961). (In Russian)

Characteristics of scintillation pulses from CsI(Tl) crystals (molar concentration 0.1 to 0.15% Tl) excited by Pu^{239} α particles and by Cs^{137} and Co^{60} γ rays were measured and tabulated. (R.V.J.)

29473 SCINTILLATION COUNTER EFFICIENCY STABILIZER. V. N. Afanas'ev (Central Scientific-Research Inst. of Ferrous Metallurgy, USSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 74-5 (Jan.-Feb. 1961). (In Russian)

The efficiency stabilizer for scintillation counters may be improved by changing the control signal from a neon tube glow to a signal produced by a controlled α flux acting on a phosphor. The suggested scheme stabilizes the source of the control signal, reduces the control pulse load, and reduces the pulse time to ~ 1 μsec instead of 1 to 2 msec. (R.V.J.)

29474 A DISCRIMINATING PHOTO-MULTIPLIER DEVICE. G. A. Kosinov, O. F. Nemets, L. S. Saltykov, and M. V. Sokolov (Inst. of Physics, Academy of Sciences, USSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 78 (Jan.-Feb. 1961). (In Russian)

The scheme of the device and pictures of pulses produced at maximum rotation (25600 rpm) with two different diaphragms are presented. The device is capable of producing front pulses of $\tau > 0.05$ μsec at a frequency $\nu < 420$ sec^{-1} and amplitudes equivalent to the NaI(Tl) crystal output when irradiated by several Mev particles. (R.V.J.)

29475 LIGHT TRANSMISSION THROUGH PLASTIC SCINTILLATORS AND LIGHT COLLECTORS. V. V. Krivitskii and G. A. Leksin. *Pribery i Tekh. Ekspt.*, 6: No. 1, 79-81 (Jan.-Feb. 1961). (In Russian)

The performance and properties of various scintillators are analyzed, and the influence of the light collector and the scintillator shape and coating on light transmission was evaluated. (R.V.J.)

29476 MEASUREMENTS OF β ACTIVE PREPARATIONS WITH 5×10^{-13} ACTIVITY. R. M. Polevoi and V. A. Pchelina. *Pribery i Tekh. Ekspt.*, 6: No. 1, 82-5 (Jan.-Feb. 1961). (In Russian)

Descriptions are given of a small 4π -flow counter with a natural background of 1 cps in a lead and anticoincidence counter screened area. The counter is capable of measuring preparations of 5×10^{-13} c, 50 times more sensitivity than end-window Geiger counters. The plateau slope and the counting efficiency were analyzed and verified. (R.V.J.)

29477 UNIVERSAL SCINTILLATION RADIOMETER RUS-3. II. GAMMA AND BETA TRANSDUCERS. I. B. Keirim-Markus, A. M. Lushchikhin, V. V. Markelov, and L. N. Uspenskii. *Pribery i Tekh. Ekspt.*, 6: No. 1, 86-91 (Jan.-Feb. 1961). (In Russian)

The performance, properties, and construction of a β - γ scintillation counter are described and compared with single-transducer and ionization detector characteristics. (tr-auth)

29478 TWENTY-CHANNEL AMPLITUDE ANALYZER. Yu. K. Akimov and A. S. Kuznetsov (Joint Inst. for Nuclear Research, Dubna, USSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 92-5 (Jan.-Feb. 1961). (In Russian)

A pulse amplitude analyzer for organic scintillators is described. The pulses are divided into two sets, corresponding to the first and second 10-channel groups. The pulse amplitudes of both groups are analyzed by one ten-channel device with a single discriminator for all channels. The analyzer dead-time is ~ 7 μsec . (tr-auth)

29479 PULSE COLLIMATOR WITH A THRESHOLD PROPORTIONAL TO ACTING PULSE AMPLITUDES. I. M. Kuks (Radium Inst., Academy of Sciences, USSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 98-9 (Jan.-Feb. 1961). (In Russian)

A scheme is described for a photoelectron device for measuring ionization in nuclear emulsions. The device is adapted for converting pulses with slanting fronts into pulses proportional to initial pulse half-width. (R.V.J.)

29480 HIGH RESOLVING INSTRUMENT FOR MEASURING NUCLEAR MAGNETIC RESONANCE SPECTRA. V. F. Bystrov, L. L. Dekabrun, Yu. N. Kil'yanov, A. U. Stepanyants, and E. Z. Utyanskaya (Inst. of Chemical Physics, Academy of Sciences, USSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 122-5 (Jan.-Feb. 1961). (In Russian)

Descriptions are given of a nuclear magnetic resonance spectrometer with high resolving power in a magnetic field of 4530 gauss. The spectrometer resolving power for 4 to 15 mm^3 specimens is $\sim 10^{-7}$. The specimen is rotated mechanically. (tr-auth)

29481 SPECTROMETER FOR MEASURING NUCLEAR MAGNETIC RESONANCE IN SOLIDS. V. V. Lemanov (Inst. of Semiconductors, Academy of Sciences, USSR). *Pribery i Tekh. Ekspt.*, 6: No. 1, 126-8 (Jan.-Feb. 1961). (In Russian)

A device, using a Franklin generator, for measuring nuclear magnetic resonance signals in solids is described. The magnitude of the least circuit voltage is reduced to 0.02 v. The performance and sensitivity of the device is evaluated. (R.V.J.)

29482 A DEVICE FOR RECORDING TOROIDAL PULSED DISCHARGE NEUTRONS. V. V. Matveev and A. D. Sokolov. *Pribery i Tekh. Ekspt.*, 6: No. 1, 130-2 (Jan.-Feb. 1961). (In Russian)

A device was designed for recording the yield and time distribution of neutrons produced in a toroidal thermonuclear installation. The device consists of a scintillation counter connected to an electronic system and is capable of recording both the pulsed neutron flux and strong x-ray emission. (R.V.J.)

29483 SECTIONAL END-WINDOW PROPORTIONAL NEUTRON COUNTER. Yu. G. Abov and B. A. Averkin. *Pribery i Tekh. Ekspt.*, 6: No. 1, 181-2 (Jan.-Feb. 1961). (In Russian)

The design is given of an easily-dismantled, cylindrical, end-window neutron counter filled with BF_3 . The construc-

n consists of a set of vertically distributed counters in a container with 15 tungsten filaments distributed in succession so as to utilize all the end-window area. (R.V.J.)

484 ATTACHMENT OF NaI(Tl) MONOCRYSTALS. G. Gutkevich, O. V. Lebedev, and N. S. Selyaninova (Inst. Radiation Hygiene, USSR). *Pribery i Tekh. Ekspt.*, 6: 1, 198-9 (Jan.-Feb. 1961). (In Russian)
A method of sticking NaI(Tl) crystals to glass or quartz with an optical adhesive is developed. The method is efficient in packing large crystals. (R.V.J.)

485 COMPARISON OF THE LIGHT OUTPUT OF IMAGE INTENSIFIER TUBES. George C. Henny and Joshua A. Becker (Temple Univ. School of Medicine, Philadelphia). *Radiology*, 77: 472-9 (Sept. 1961).

Four image-intensification tubes are compared with respect to roentgens per minute at the primary screen vs milliamperage at the secondary screen (efficiency). The parameters for the brightness levels from the input x-ray spectrum (kilovolts, kvp) of image-intensifier tubes variations in milliamperage and r per minute produce little change in the efficiency of tube operation. However, at either low or high kilovoltage, the ability of the tube to convert x rays into light falls off. No tube tested had both the most responsive input screen and the most responsive output phosphor. This combination would be optimal for peak efficiency. However, in final judgment, the tube with the greatest light output per incident r per minute (efficiency) is the most desirable, regardless of how this effect is produced. The observations indicate that the differing efficiencies between tubes are directly dependent on phosphor screen efficiencies. (auth)

486 PHOTOELECTRONIC IMAGE INTENSIFIERS. D. McGee (Imperial Coll. of Science and Tech., London). *Phys. Progr. in Phys.*, 24: 167-211 (1961).

The limits to the detectability of an image by the statistical fluctuations resulting from the quantum nature of light are analyzed and the efficiency of the photoelectric effect as a detector of optical images is compared with that of the photographic effect. Possible methods of using the photoelectric effect for image detection are enumerated and image intensifiers using free electrons are discussed. (J.N.N.)

487 FAST COINCIDENCE SYSTEM BASED ON A TRANSISTORIZED TIME-TO-AMPLITUDE CONVERTER. J. C. Simms (Columbia Univ., New York). *Rev. Sci. Instr.*, 32: 894-8 (Aug. 1961).

The time-to-amplitude converter is designed for time measurements in the 10^{-7} to 10^{-11} sec range. The time resolution of the system is defined as the full width at half maximum of the amplitude distribution produced by the time converter in response to prompt coincidence events. The best time resolution obtained was 4.7×10^{-10} sec. The time converter and all of the accessory circuits are described. (auth)

488 ELECTRONEGATIVE GAS DETECTOR. R. E. Cox, P. R. Malmberg, and R. B. Gosser (Westinghouse Electric Corp., Pittsburgh). *Rev. Sci. Instr.*, 32: 898-901 (Aug. 1961).

An electronegative gas detector was developed which is capable of measuring one part of SF_6 in 10^7 parts of air. The operation of the instrument is based on the differences between various electronegative gases in the rates of electron attachment at low electron energies, and on the differences of mobilities of the resulting negative ions in an electric field. The instrument operates at atmospheric pressure ($E/p \sim 1$ v/cm-mm Hg) and uses a modulated ultraviolet light source to produce at a photocathode pulses

of photoelectrons which are attached to produce negative ions. The differences in cathode-anode transit times of the negative ions result in different phase shifts of the observed cathode current. The measured phase shifts serve to indicate the amount of electronegative gas present. (auth)

29489 REFLEX KLYSTRON AS A HIGH SPEED MICROWAVE SWITCH. B. G. Whitford (National Research Council, Ottawa). *Rev. Sci. Instr.*, 32: 919-21 (Aug. 1961).

Nanosecond switching of rf power is achieved using a reflex klystron in a nonoscillating state for amplitude modulation. The variation of klystron input admittance with reflector potential is used. A review of reflex klystron theory is presented explaining the technique. Experimental work at X band using a hybrid T to separate reflected power from power incident on the tube shows that flat-topped rf pulses with rise time of 1.5 nsec and decay time of 6 nsec are possible. Switch "off" relative to switch "on" attenuation of 30 db was obtained with a reflector voltage swing of 10 v. It is believed that the technique is applicable at any frequency where reflex klystrons are available. (auth)

29490 IMPROVED CONTINUOUSLY SENSITIVE BUBBLE CHAMBER. Ryuhei Kato (Ritumeikan Univ., Kyoto). *Rev. Sci. Instr.*, 32: 926-7 (Aug. 1961).

An improved type of continuously sensitive bubble chamber was constructed. In order to increase the sensitive volume and the sensitive time, the geometrical size and the heating system of the chamber were improved. Using an organic liquid and carbon dioxide solution as a liquid, this chamber is sensitive to fast neutron irradiation. (auth)

29491 DIE FORMING DOUBLY FOCUSING X-RAY MONOCHROMATORS. Harold J. Garrett and J. Harry A. Lipsitt (Aeronautical Research Lab., Wright-Patterson AFB, Ohio). *Rev. Sci. Instr.*, 32: 942-5 (Aug. 1961).

Forming techniques for the preparation of doubly curved LiF x-ray monochromators are described. These techniques are applicable to the formation of doubly focusing one piece monochromating crystals with geometries suited to a wide range of experimental requirements. The resulting dislocation structures were analyzed and utilized in the development of the techniques and are presented as a guide for the preparation of similar focusing crystals. (auth)

29492 HIGH YIELD GENERATOR OF PULSED 14-Mev NEUTRONS. J. V. Braddock, T. G. Bullen, B. J. Dunn, D. F. McDonald, and H. A. Miranda, Jr. (Iona Coll., New Rochelle, N. Y.). *Rev. Sci. Instr.*, 32: 946-9 (Aug. 1961).

Apparatus for obtaining 14-Mev neutrons in pulses of approximately 10- μ sec duration is described. It employs a gaseous discharge in deuterium at low pressure whereby deuterons of up to 180-kev energy are generated and accelerated into a tritiated zirconium target. This method provides a much greater abundance of deuterons than has been obtainable with ion guns. In its present form the device constructed has given yields approaching the theoretically expected value of 10^{10} neutrons per pulse. (auth)

29493 TOTAL ABSORPTION LEAD GLASS ČERENKOV COUNTER. G. Gatti, G. Giacomelli, W. A. Love, W. C. Middelkoop, and T. Yamagata (CERN, Geneva). *Rev. Sci. Instr.*, 32: 949-52 (Aug. 1961).

A total absorption lead glass Cherenkov counter to be used as γ -ray and electron spectrometer in the 1-10 Bev region is described. The calibration of the counter with monoenergetic electrons shows its response to be linear at least up to 14 Bev. The pulse-height spread improves with increasing energy and it is better than 10% (full width at half-height) for energies above 5 Bev. (auth)

29494 CO₂-CS₂ GEIGER COUNTER. H. R. Crane (Univ. of Michigan, Ann Arbor). *Rev. Sci. Instr.*, 32: 953-62 (Aug. 1961).

Experiments on the mechanism and characteristics of a CO₂-CS₂ Geiger counter are reported, and circuits and methods of operation which satisfy the special requirements are described. Counter: The active part is 2 $\frac{7}{8}$ in. in diameter and 16 in. long, filled to 1 atm, 95% CO₂ and 5% CS₂. The cathode is copper and the anode is 0.005-in.-dia. Chromel A. Characteristics: The electrons released by an ionizing particle become attached, probably to CS₂. The self-quenching action of the counter is excellent, no spurious counts are observed in the absence of electronic quenching. However, a dead time of several milliseconds must be imposed electronically because of the long interval during which the negative ions arrive at the anode. Method: An electronic quench is used which is triggered both by the CO₂-CS₂ counter and the anticoincidence ring. This serves to impose the required dead time and also to prevent the firing of the CO₂-CS₂ counter by mesons. Measurements: The plateau was measured to 1900 v above threshold and was found to be level to within 1% from 400 to 1600 v above threshold. The maximum drift time of the negative ions was found to be about 9 msec with a sharp cutoff. Tests with various combinations of gas indicated, but did not prove, that the charge carrier was CS₂. The effects of common contaminants were determined. At voltages over 400 above threshold, 1% O₂ gave no detectable effect; 0.3% SO₂ gave a 2 to 3% reduction in counting rate. Extensive tests of the efficiency were made. Comparisons of the CO₂-CS₂ filling with an argon-ethane filling gave identical results within the experimental error. No basis was found for supposing that there was any failure of the CO₂-CS₂ counter to register counts. Reliability: The counter described has been used for C¹⁴ dating purposes over a long period of time. There has been no indication that there are variations in counting rate outside those expected on the basis of statistics. The counting rate for "dead" CO₂ in an iron shield 9 in. thick and after anticoincidence is 8 per min. (auth)

29495 CAVITY METHOD SUITABLE FOR MEASUREMENT OF HIGH ELECTRON DENSITIES IN PLASMAS. J. M. Anderson (General Electric Research Lab., Schenectady, N. Y.). *Rev. Sci. Instr.*, 32: 975-8 (Aug. 1961).

It is shown that a columnar geometry of electrical gaseous plasma may be examined by the conventional microwave cavity method, and results may be interpreted such that plasma electron densities considerably above that corresponding to "resonance" with the applied microwave frequency may be determined. (auth)

29496 NEW PULSE ENCODER. H. I. Pizer (CERN, Geneva). *Rev. Sci. Instr.*, 32: 988 (Aug. 1961).

A new pulse amplitude encoder was designed on the following principle: A ringing circuit, with feedback adjusted close to free oscillation, is pulsed by the input signal, and begins to oscillate with a proportional amplitude. A constant-current diode device then removes from the tuned circuit, during each negative half-cycle, a constant amount of charge such that the amplitude of oscillation, which would otherwise remain constant, is reduced linearly. Consequently the total number of oscillations is proportional to the input pulse amplitude. (L.N.N.)

29497 AN IMAGE INTENSIFIER SPARK TUBE. M. Inoki (Yamanashi Univ., Kofu City, Japan). *Rev. Sci. Instr.*, 32: 994-5 (Aug. 1961).

A type of high gain image intensifier, called an image intensifier spark tube, in which the phosphor of a presently

available image intensifier is replaced with a recently developed spark chamber, is discussed. A schematic diagram is presented. (L.N.N.)

29498 MASS-MONOCROMATOR WITH DOUBLE FOCUSING IN SECTOR MAGNETIC FIELD. V. A. Molchanov and V. G. Tel'kovskii (Scientific Research Inst. of Nuclear Physics, [USSR]). *Vestnik Moskov Univ.*, Ser. III, 16: No. 1, 22-8 (Jan.-Feb. 1961). (In Russian)

A device was designed for experiments with ion beams and for separating small amounts of isotopes. Double-focusing in the sector magnetic field enables operation with 1-cm dispersion per % relative mass difference. The ion current density near the focus is 2 to 3 ma/cm². (tr-auth)

29499 EQUIVALENCE OF TIME AND ELECTRON BEAM INTENSITY IN THE IRRADIATION OF PHOTOGRAPHIC PLATES OF TYPES MK(MK) AND MP(MR). I. A. Fomina and K. S. Bogomolov (Moscow Power Inst. and All-Union Scientific Research Motion Picture and Photographic Inst. (NIKFI), USSR). *Zhur. Nauch. i Priklad. Fot. i Kinematografii*, 5: 293-4 (1960).

The photographic density is shown as a function of electron beam intensity at constant charge density (2×10^{-12} c/cm²) for MK, MR, and spectral Type 1 emulsions. The electron energy was 60 kev. The reciprocity law holds for the MK and MR emulsions, and the plates can be used in quantitative work with electron beams. The emulsions also have a high resolving power, which is due to small dimensions of microcrystal and small intervals between them. Nevertheless, the emulsions have a high sensitivity. (OTS)

29500 NUCLEAR PHYSICS MEASURING INSTRUMENTS AND TECHNIQUES. BIBLIOGRAPHICAL COMPILATION. C. SELECTED REFERENCES ON THE SUBJECT. (Max-Planck-Institut für Physik und Astrophysik, Munich). July 1, 1961. 58p. (AED-C-06-4). (In German)

A compilation of references on nuclear physics measuring instruments and techniques is presented. A total of 247 references is arranged according to subject. Author and report number indexes are included. (M.C.G.)

29501 RADIATION RESPONSIVE AND DETECTING DEVICE. Gesinus Diemer, Pieter Zalm, and Hendrik A. Klasens (to N. V. Philips' Gloeilampenfabrieken). Canadian Patent 621,206. May 30, 1961.

A radiation-responsive device is described which is suited to the reproduction of images, especially in the reversed state. The device comprises a photosensitive semiconductor layer and a luminescent layer connected with an a-c supply, the luminescent layer being subject to field quenching. When an image is projected on the photosensitive layer while the luminescent layer is being irradiated by u-v light, the luminescence is quenched in varying degrees according to the intensity of the projected image, leading to the reversion of the image on the luminescent layer. A similar device is provided with quenching in the photosensitive layer so that the image is not reversed. (D.L.C.)

29502 METHOD OF PRODUCING RADIATION SENSITIVE, SINTERED BODIES CONTAINING CADMIUM SULPHIDE. Willem van Gool, Johannes G. van Santen, and Hubertus J. J. Brech (to N. V. Philips' Gloeilampenfabrieken). Canadian Patent 621,284. May 30, 1961.

An improvement is proposed for the method disclosed in Canadian Patent 589,927 for producing sintered cadmium oxide-cadmium sulfide bodies suitable for use in radiation-sensitive devices. The improvement consists of using in the place of cadmium oxide a cadmium compound that decomposes to the oxide at the sintering temperature between

700 and 1200°C; the resulting sintered bodies are more homogeneous. Examples of such compounds are the oxalate, carbonate, and nitrate. The preferred final amount of oxide in the mixture is 0.1 to 5 wt %. (D.L.C.)

29503 GEIGER-MULLER COUNTER AND RADIATION MEASURING APPARATUS. Johannes Hermesen and Kars van Durren (to N. V. Philips' Gloeilampenfabrieken). Canadian Patent 621,293. May 30, 1961.

An improved guard counter and anticoincidence arrangement is designed which has a volume and weight much less than previous arrangements. The arrangement has the guard counter formed of two bell-shaped, concentric electrodes surrounding the sample counter. (D.L.C.)

29504 RADIATION ABSORPTION TYPE FINE MATERIAL COMPOSITION ANALYZER. Bauke S. Sieswerda and Aart L. Van Der Mooren (to Stamicarbon N. V.). Canadian Patent 626,225. Aug. 22, 1961.

An apparatus for measuring properties of granular material is described which uses a radiation source. The apparatus comprises a disc support which receives the material to be analyzed and is rotated through a radiation source; the resulting radiation absorption gives a measure of the material composition. Means is provided for making discontinuous or continuous measurements. The apparatus is suitable for determining the ash content of coal samples. (D.L.C.)

29505 MASS SPECTROMETER. Anton M. Klopfer (to N. V. Philips' Gloeilampenfabrieken). Canadian Patent 626,519. Aug. 29, 1961.

An omegatron mass spectrometer is designed which is capable of making reproducible measurements. (D.L.C.)

Materials Testing

29506 (APEX-657) PHOTOTHERMOELASTIC INVESTIGATION OF HEXAGONAL PLATES. Angelo Colao and Herbert Becker (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Apr. 28, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 22p.

Stresses in hexagonal plates were determined by means of a photothermoelastic investigation with theoretical support from an engineering analysis. The results are reported as concentration factors, $C = \sigma/\alpha ET$. For a blank hexagonal plate, it was found experimentally that $C = -0.285$ on the edges, while for a hexagonal plate with a central hole $C = -0.270$ on the outer edges and $C = +0.302$ on the hole boundary. (auth)

29507 (APEX-668) PHOTOTHERMOELASTICITY TECHNIQUES AND APPLICATION. Warren E. Greenwald (General Electric Co. Flight Propulsion Lab. Dept., Cin-

cinnati). June 26, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 23p.

The use of photoelasticity to measure thermal stresses in reactor components and the correlation of the results with the reactor prototype are discussed. The specific techniques and the problems encountered are also discussed. (D.L.C.)

29508 (ER-10911-9) EVALUATION OF ULTRASONIC TEST DEVICES FOR INSPECTION OF ADHESIVE BONDS. Summary Report, July 1, 1959 through July 31, 1961. John P. Reese and Von H. Boruff (Martin Co., Baltimore). Aug. 1961. Contract NOAS 59-6266-C. 173p.

Selected ultrasonic, nondestructive test instruments were evaluated for their capability to detect bond strength variations in adhesive bonded structure. Various adhesives and adherends were utilized. Investigations were conducted on both laboratory-scale panels and full-scale production assemblies. The instruments proved capable of detecting unbonded areas (voids), porosity and bond thickness variation. They were not effective in the detection of substandard bonds due to poor surface preparation or under-cure of the adhesive. They showed some capability of detecting bond degradation in service due to fatigue, heat exposure or corrosion. (auth)

29509 (NP-10555) THE APPLICATION OF LOW VOLTAGE RADIOGRAPHY TO MAGNOX AL80. G. F. Linsley (United Kingdom Atomic Energy Authority. Reactor Group, Springfields, Lances, England). May 24, 1961. 23p. (TRG-Report-6)

The quality of a radiograph depends on the contrast and resolution. The factors affecting these are discussed theoretically and examined experimentally for a range of equipment. This leads to formulation of optimum conditions for the radiography of Magnox AL80 in thicknesses of 0.050 to 0.500 in. for the detection of small cavities. (auth)

29510 (UCRL-13019) STRESSES INDUCED IN A SEMI-INFINITE SOLID BY A CENTER OF COMPRESSION. (Colorado School of Mines Research Foundation, Inc., Golden). July 20, 1961. For Univ. of California Lawrence Radiation Lab., Livermore. 14p.

A mathematical treatment is presented for the stresses induced in a semi-infinite elastic medium by a center of compression located within the solid. The bounding surface is assumed to be a plane free from stress. (D.L.C.)

29511 NONDESTRUCTIVE TESTING OF PRESSURE VESSELS. John Battema. Can. Welder, 52: 10-16 (Feb. 1961).

A survey is given of nondestructive inspection procedures for welded pressure vessels, including the use of air and water; magnetic particles, x rays, and isotope radiation; dye and fluorescent penetrants; and ultrasonics. (TCO)

GEOLOGY, MINERALOGY, AND METEOROLOGY

29512 (CNI-83) MISURE DI TEMPERATURE SULLA TORRE METEOROLOGICA DI ISPRA. (Measurements of Temperatures in the Meteorological Tower of Ispra). A. Anzani and C. Gandino (Italy. Comitato Nazionale per le Ricerche Nucleari. Centro di Studi Nucleari, Ispra). Dec. 1960. 29p.

The vertical temperature fluctuations of the air near the earth's surface and their diurnal effects are explained. The electrical resistance thermometers for the meteorological tower of Ispra are illustrated. (auth)

29513 (DASA-1222) MIXING AND TRANSFER WITHIN THE STRATOSPHERE. Progress Report on HASP. Herbert W. Feely and Jerome Spar (Isotopes, Inc., Westwood, N. J.). Dec. 31, 1960. Contract DA-29-044-XZ-609. 67p.

Preliminary data on Phases 4 and 5 of Crowflight are given. The recalibrated U-2 duct curves are given. Tritium and Carbon-14 concentrations in New Jersey rain and air samples during 1959 and 1960 respectively are reported. The manner of mixing and transfer of Strontium-90 in the stratosphere is described. The seasonal increase in mixing from the tropical to polar regions is noted. Tungsten-185 distributions are discussed. Measurements of Rhodium-102 indicate that Teak and Orange debris has entered the lower stratosphere. A mean residence time of less than 10 years for this debris is suggested. Concentrations of Beryllium-7, a cosmic-ray product, are reported. Strontium-89 and Cerium-144 data are discussed in the light of the HASP mixing model. The size distribution and composition of stratospheric particles collected on electron microscope probes exposed in the stratosphere are described. Particles in the size range 0.1 to 1.5 microns appear to be composed of ammonium persulfate. A stratospheric inventory of 3.2×10^5 Kg of SO_4 is deduced. (auth)

29514 (TEI-757) GEOLOGIC RECONNAISSANCE OF THE TOPOPAH SPRING AND TIMBER MOUNTAIN QUADRANGLES, NYE COUNTY, NEVADA. P. P. Orkild and J. S. Pomeroy (Geological Survey, Washington, D. C.). May 1960. 26p.

The Topopah Spring and Timber Mountain 15 minute quadrangles comprising about 500 square miles in southern Nye County, Nevada were given a geologic survey. Geology, stratigraphy, geozoic rocks, and structure faults, folds, and unconformities are discussed. Index and reconnaissance geologic maps are included. (M.C.G.)

29515 (UCRL-13015) SOURCES OF INFORMATION ON ROCK PHYSICS. Current Literature, July 1961. Lorraine Burgin (Colorado School of Mines Research Foundation, Inc., Golden). July 31, 1961. For Univ. of California Lawrence Radiation Lab., Livermore. 54p.

A bibliography of 133 references is given which covers rock physics, rock mechanics, wave propagation, and other related subjects. Abstracts are included for many of the references. (D.L.C.)

29516 (AEC-tr-4778) PRINCIPLES OF A METHOD FOR STUDYING THERMAL CONDITIONS IN SOIL. A. F. Chudnovskii. Translated for Los Alamos Scientific Lab. from Zhur. Tekh. Fiz., 16: 243-8(1946). 7p.

The principles of non-stationary procedures for determining the thermal characteristics of soil, by introducing a linear rod as an isothermal or instantaneous heat source, are presented. The following assumptions were made: that the proportion of cylinder length to thickness is great, that

the field is homogeneous in a direction radial to the axis of the probe, and that regular conditions should be established in the soil some time after the probe is placed in it. The heated cylindrical rod is placed in the soil and a thermometer is also placed in the soil a short distance from the axis of the rod. It is unnecessary to measure either the absolute value or changes in the temperature of the soil, only distance and time. (M.C.G.)

29517 THE ESTIMATION OF AREAS WITHIN ISO-PLETHS OF DOSAGE DOWNWIND OF A POINT SOURCE. William P. Elliott and Paul W. Nickola (Air Force Cambridge Research Labs., Bedford, Mass. and General Electric Co., Richland, Wash.). Am. Ind. Hyg. Assoc. J., 22: 238-44(Aug. 1961). (HW-SA-2188)

A method is presented for estimating the area enclosed by an isopleth of dosage downwind of a point source in the atmosphere. The method employs an empirical relationship between the area enclosed by a dosage isopleth and the value of the isopleth divided by the source strength and multiplied by wind speed. The relationship is classified according to atmospheric stability. Comparisons are made between results obtained over short grass (O'Neill, Nebraska) and arid sagebrush vegetation (Hanford, Washington). (auth)

29518 X-RAY STUDY OF AUTUNITE. Yukio Takano (Tokyo Univ.). Am. Mineralogist, 46: 812-22(July-Aug. 1961).

The autunite-meta-autunite I—meta-autunite II series was studied by x-ray diffraction. By studying the process by which autunite is dried and heated until it finally forms a high temperature phase, the diffraction pattern of each phase was determined. Single crystals were analyzed by the Weissenberg method, and the lattice constants and space groups were determined. The large cell proposed for meta-autunite was not found. Meta-autunite II is orthorhombic, with $a_0 = 6.55$, $b_0 = 7.05$, and $c_0 = 8.16$ Å. This c_0 value is smaller than the c_0 of the meta-autunite I, contrary to the values hitherto reported. (auth)

29519 DATING CHALK PRECIPITATES WITH RADIOACTIVE CARBON. H. W. Franke, K. O. Münnich, and J. C. Vogel (Universität, Heidelberg, Ger.). Atompraxis, 7: 298-300(Aug. 1961). (In German)

It is shown that secondary chalk precipitates contain radioactive carbon and can be dated with the C^{14} method. The initial C^{14} content of chalk sinter is higher than expected, owing to exchange effects. The necessary corrections are made in part by measuring the $\text{C}^{13}/\text{C}^{12}$ isotope ratio. The first measurement results are given. (tr-auth)

29520 THE RATIO OF RADIOACTIVITIES IN DEPOSITS OF THE AZOV SEA AND OF THE BLACK SEA. I. E. Starik, D. S. Nikolaev, Yu. V. Kuznetsov, and V. K. Legin. Doklady Akad. Nauk S.S.S.R., 139: 456-9(July 11, 1961). (In Russian)

The distributions of U, Th, Io and Ra contents as a function of depth in 5.0-meter core samples from three stations in the Azov Sea were investigated in the summer of 1959. The absolute contents of U, Th, Io and Ra in sediments of the Azov Sea are approximately the same as those in littoral ocean deposits. The average uranium concentration in sediments of the Azov Sea was 1.3×10^{-6} grams per gram of sludge, while the uranium in the upper layers of the Black Sea sediments was 5.7×10^{-6} g/g. The average concentration of thorium is greater in deposits of the Azov

ea than it is in deposits of the Black Sea, but the concentration of ionium is somewhat greater in deposits of the Black Sea than it is in deposits of the Azov Sea. Apparently, the main part of the ionium precipitates from solution after being formed from the uranium in solution. The concentration of Ra was found to be 7.2×10^{-13} g/g of sludge in the Azov Sea. The Ra is continuously carried down by sediments which act as carriers. Hence, the amount of Ra is almost twice the equilibrium amount based on the amount of U present in solution. The ratio of Th to U is variable, but is always greater than three. (TTT)

29521 INVESTIGATION OF SNOW MELTING BY THE MELTING OF RADIOACTIVE ISOTOPES. Yu. N. Agashkin. *Izvest. Akad. Nauk S.S.S.R., Ser. Geograf., No. 4, 117-21 (1960).*

The process of springtime snow melting was observed by means of radioactive isotopes. Special devices were used to measure the change in the intensity of rays after passing through the mass of snow, the source of radiation being located under the snow cover. The instrument used consists of a stand with a scale measuring the depth of snow; to this stand is attached a bracket that holds the counter tube. The bracket can be adjusted so that the receiving part is removed a distance from the bottom of the stand exceeding the thickness of the snow cover. Below the receiving part a 7 mm lead tube is placed in the snow so that it reaches the ground. The isotope is introduced through the tube. The observation conducted covered 5 different points, covering an area of 50% mixed forest and 50% fields and pasture land. Each emplacement is described, giving full characteristics of location, soil, and thickness of snow cover. Measurements were started on March 8 and continued till the end of snow melting; readings were taken at first once a day and later from 2-7 times during 24 hr. The water run-off depended entirely on the local conditions of microrelief and was most pronounced in the mixed forest and on the clearing. During 5 consecutive days of intense melting on a clover field, the average daily loss of snow was 28 mm (lowest 7, highest 50 mm). On the clearing, the daily water yield amounted on the average to 20 mm in 24 hr (varying from 7 to 46 mm). In the forest, the basic period of thawing spread over a long period, lasting about 12 days at an average water yield of 17 to 36 mm. It was concluded that the method is fully reliable. (OTS)

29522 THE URANIUM ISOTOPES IN THE NATURE. I. ACTINIUM-RADIUM RATIO OF MINERALS. V. V. Cherdyn'tsev, U. Kh. Asylbaev, D. P. Orlov, L. I. Shmonin, E. A. Isabaev, and N. B. Kadyrov (Geological Inst., Academy of Sciences, Moscow and Kazakh State Univ., Alma-Ata, USSR). *Geokhimiya, No. 8, 650-5(1961).* (In Russian)

The actinium-radium ratio was investigated in 35 natural minerals by two methods. Considerable deviations of the actinium-radium ratio were observed in metamorphosed minerals. In some cases it may be shown with certainty that this is caused by the migration removal of radium. At the same time some primary minerals also contain an actinium excess which is especially great for cassiterites and some molybdenites. (auth)

29523 ON THE DEPENDENCE OF THE PHYSICAL PROPERTIES OF APATITE ON THE ADMIXTURE OF RARE EARTHS AND STRONTIUM. A. P. Denisov, O. B. Dudkin, N. A. Elina, R. A. Kravchenko-Berezhnai, and L. I. Polezhaeva (Kola Branch, Academy of Sciences, USSR). *Geokhimiya, No. 8, 666-75(1961).* (In Russian)

The dependence of the parameters of the apatite elementary cell, its specific weight, the refraction indexes, and

their dispersion on the lanthanoid and strontium content was studied. Spectra of microcrystalline mounts were obtained and studied in passing light. In case of a heterovalent calcium replacement in apatite by lanthanoids, all the investigated physical properties change noticeably. In a number of cases the change of the elementary cell parameters, the specific weight, and the refraction indexes may not be proportional to the change of the lanthanoid content, which is explained by the compensation of the valencies in different ways. In case of an isovalent replacement of calcium in apatite by strontium, the parameters of the elementary cell change rectilinearly and proportionally; in this case the refraction indexes are unchanged. (auth)

29524 THE RELATIONSHIP BETWEEN PEAK AND MEAN CONCENTRATIONS. Irving A. Singer (Brookhaven National Lab., Upton, N. Y.). *J. Air Pollution Control Assoc., 11: 336-41(July 1961).* (BNL-4867)

A method of predicting average concentrations is presented. It is shown that the simplified normal bivariate distribution describing the average concentration pattern is composed of various short-term periodic distributions which may differ from it significantly. A descriptive, empirical method is described which indicates an exponential relationship exists between these shorter time or peak concentrations and average conditions. The slope of the exponent appears to be proportional to the stability or the gustiness. Downwind, the peaks are normally within an order of magnitude greater than average concentrations, whereas crosswind, the peaks may be several orders of magnitude larger. (auth)

29525 THE CHARACTERISTICS OF THE NINGYŌ-TŌGE ORE. ESPECIALLY COMPARISON WITH THE REPRESENTATIVE ORES ABROAD. Motoo Satō, Kazuhisa Nozawa, and Shigeru Okada (Atomic Fuel Corp., [Tokyo]). *J. At. Energy Soc. Japan, 3: 541-59(July 1961).* (In Japanese)

The mineralogical characteristics of Ningyō-tōge ore were studied with reference to uranium processing and compared with ores from representative mines in foreign countries. The uranium contents of the Ningyō-tōge ore, about 0.06 to 0.1% U_3O_8 , are comparatively lower than those of foreign ores, which generally range over 0.1% U_3O_8 . In spite of such low uranium contents, the Ningyō-tōge ore has good qualities as uranium raw material. The ore is very loose and uranium has a tendency to be more concentrated in the fine part, so that washing and screening are sufficiently effective. The structure of the ore is so porous that the leaching solution can penetrate very easily, and the uranium minerals of the ore are readily dissolved in acid. The ore has the simple mineral association, and it includes scarcely unfavorable materials for extraction and recovery processes of uranium. Also, there is no trouble from impurities having high neutron absorption cross sections. (auth)

29526 THE ELECTRICALLY SHORT ANTENNA AS A PROBE FOR MEASURING FREE ELECTRON DENSITIES AND COLLISION FREQUENCIES IN AN IONIZED REGION. Ronald King, C. W. Harrison, Jr., and D. H. Denton, Jr. (Sandia Corp., Albuquerque, N. Mex.). *J. Research Natl. Bur. Standards, 65D: 371-84(July-Aug. 1961).* (SCR-257)

If the admittance of a missile, satellite, or drone-aircraft antenna is monitored as the vehicle traverses an ionized region, it is possible to determine the free electron density and the collision frequency of the region if theoretical relations between these quantities are available. Formulas are developed that relate the admittance of an electrically short center-driven dipole or a base-

driven monopole when immersed in a conducting dielectric of the medium. From well-known formulas relating these quantities to the free electron density and the collision frequency of an ionized region, these latter may be determined directly from measured admittances. The results obtained when the antenna is treated as a lumped capacitor are considered. It is shown that when the conductivity of the medium is increased to a value that is still quite small, the effect of radiation on the input admittance becomes negligible. The electrically short antenna immersed in sea water is discussed briefly. (auth)

29527 SEASONAL VARIATIONS OF CAESIUM-137 IN AIR AT GROUND-LEVEL. K. G. Vohra, V. S. Bhatnagar, and C. Rangarajan (Atomic Energy Establishment, Trombay, India). *Nature*, 191: 747-8 (Aug. 19, 1961).

Data are presented on the Cs^{137} concentrations, gross β activity, and ratios of Cs^{137} to gross β activity at Bombay, India, from 1956 through 1960. Monthly Cs^{137} data are included for 7 other stations in India for the years 1959 and 1960. An increase in Cs^{137} during the early spring is attributed to seasonal effects due to mixing between the stratosphere and the troposphere. (C.H.)

29528 WORLD-WIDE CIRCULATION OF AIR WITHIN THE STRATOSPHERE. P. Goldsmith (Atomic Energy Research Establishment, Harwell, Berks, Eng.) and F. Brown. *Nature*, 191: 1033-7 (Sept. 9, 1961).

Recent data on humidity mixing ratio, fission product fallout from nuclear weapon tests, humidity and tritium concentrations at heights of about 90000 ft over England, and the world-wide distribution of W^{185} in the stratosphere up to 70000 ft are discussed. A modified Dobson-Brewer stratospheric model, which is consistent with the new results and also in accord with other data on the distribution of radioactive debris, water vapor, and ozone within the stratosphere, is described. Several points on the consistency of the model are given. (P.C.H.)

29529 THE ATTACHMENT OF DECAY PRODUCTS OF NATURAL EMANATIONS ON ELECTRICALLY CHARGED AEROSOLS (SUSPENDED MATTER). Lars Lassen (Universität, Heidelberg, Ger.). *Z. Physik*, 163: 363-76 (1961). (In German)

Previously an equation was derived for the attachment of the decay products of radon and thoron to aerosol particles. Considering the deposition to be solely governed by thermal diffusion (not by electrostatic forces) and assuming a quasi-stationary density distribution for the diffusing atoms, it was shown that the attached activity is proportional to $R^2/(1 + hR)$ where R is the particle radius and $h = 7 \cdot 10^4$

cm^{-1} at NTP. As most aerosols in nature are electrically charged, it is shown how the diffusion process is modified by the influence of electrostatic forces between diffusing ions and charged aerosol particles. For the frequently occurring case of a symmetrically bipolar charged aerosol and ion diffusion it is furthermore shown that the attached activity is proportional to $[R^2 F(R, x)/(1 + hR)]$ where x is dependent on the electrostatic charge and the radius of the aerosol particles. Applying this equation to the deposition of natural radioactivity on atmospheric aerosols and assuming that particle size-distribution can be roughly approximated by a law $N(R) = \text{const} \cdot R^{-3}$ in the range $10^{-6} \text{ cm} \leq R \leq 10^{-3} \text{ cm}$ calculation shows that 90 to 95% of the total natural radioactivity should be attached to particles smaller than $R = 5 \cdot 10^{-6} \text{ cm}$ and as much as 50 to 75% to particles smaller than $R = 5 \cdot 10^{-6} \text{ cm}$. It is concluded that the distribution of natural radioactivity on the different particle sizes in atmospheric and artificial aerosols is fundamentally dependent upon the diffusion process, including ionic diffusion. (auth)

29530 GEOLOGY AND MINERAL DEPOSITS OF THE CARLILE QUADRANGLE, CROOK COUNTY, WYOMING. M. H. Bergendahl, R. E. Davis, and G. A. Izett (Geological Survey, Washington, D. C.). *Geological Survey Bulletin* 1082-J. 1961. 93p. GPO.

29531 DYNAMIC METEOROLOGY. (Dinamicheskaya Meteorologiya). V. A. Belinskii. Translated from a publication of the State Publishing House of Technical-Theoretical Literature, Moscow-Leningrad, 1948. 601p. (OTS-60-21154; PST-Cat. 120). \$6.00(OTS).

A textbook of dynamic meteorology is presented. Topics covered include the thermodynamics of ideal gases, the thermodynamics of water phases, the thermodynamics of moist air, the statics of the atmosphere, the stability of static equilibrium, radiation, the equations of hydromechanics and thermodynamics, equations of the theory of radiation, the equations of motion of the atmosphere and their simplification, simple atmospheric motions without friction, the geostrophic wind variation with altitude, the mechanism of pressure variation, atmospheric interfaces, kinematics of the pressure field, turbulent exchange and spectral structure of turbulence, wind variation with altitude in a turbulent atmosphere, the energy of atmospheric motions, general circulation of the atmosphere, the theory of perturbation of atmospheric flows, I. A. Kibel's theoretical method of weather forecast, and integration of the weather equations. (M.C.G.)

HEALTH AND SAFETY

Refer also to abstract 29386

29532 (A/AC.82/G/L/577) THE 90-STRONTIUM CONTENT OF HUMAN BONES AND TISSUES IN 1958, 1959 AND 1960. Dietrich Merten (Germany. Bundesforschungsanstalt für Milchwirtschaft, Physikalisches Institut, Kiel) and Otto Pribilla (Kiel. Universität. Institut für Gerichtliche und Soziale Medizin). Jan. 2, 1961. 15p.

Submitted by Bundesministerium für Atomkernenergie und Wasserwirtschaft, Germany.

The Sr^{90} content of human bones and tissues was determined according to its variations with time. The discrimination factors of diet/bone and diet/tissue were found to be about 8 and 1.3 respectively. A linear correlation between the contamination level of milk and that of the bones of new-borns was found. This correlation may be used to predict future contamination levels in bones for a given contamination level in milk. (auth)

29533 (A/AC.82/G/L.584) DIETARY LEVELS OF STRONTIUM-90 AND CESIUM-137. A Summary of World Information. (Food and Agriculture Organization of the United Nations, Rome). 1961. 56p.

Values for the concentration of Sr^{90} and Cs^{137} in food in the years 1957 to 1960, from all countries for which information is available, are summarized. The following factors are given, as far as they are available, for each value: country, year and month of sampling, type of sample, the area and the number of sites in the area from which the samples were taken, the sampling point, the frequency of sampling, and the method used in respect to bulking of samples. The following tabulations were made: Sr^{90} in milk, cheese, cereals, vegetables, fruit, meat, eggs, fish, baby foods, tea, and total diet and Cs^{137} in the diet. (M.C.G.)

29534 (AERE-R-3552) RADIOSTRONTIUM AND RADIOCAESIUM IN DRINKING WATER IN THE UNITED KINGDOM, RESULTS TO DECEMBER 1960. R. N. Crooks, R. G. D. Osmond, and T. J. Webber (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). June 1961. 20p.

The measurement of radiostrontium and radiocesium in a number of drinking water supplies in the United Kingdom was continued. The mean Sr^{90} content of supplies derived from reservoirs and lakes reached a maximum of 1.2 picocuries per liter in the third quarter of 1959, and then decreased but more slowly than the concentration in rain. The corresponding figure for supplies from rivers was 0.6 picocuries per liter in the second quarter of 1959. Amounts of Cs^{137} were lower than those of Sr^{90} and varied considerably from one supply to another. As before very little activity was found in well waters. Results suggest that heavy rain may wash out previously deposited Sr^{90} from soil and that sand filtration has little effect on the amount of the two radionuclides in water. (auth)

29535 (AERE-R-3555) THE FATE OF RADIOACTIVE EFFLUENT DISCHARGED FROM A.E.R.E. HARWELL INTO THE RIVER THAMES. I. A PRELIMINARY SURVEY. A. Morgan and G. M. Arkell (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1961. 26p.

Liquid radioactive waste is discharged into the River

Thames from the Atomic Energy Research Establishment Harwell, in accordance with Authorizations granted by the Ministries of Housing and Local Government and of Agriculture, Fisheries and Food. A preliminary radiometric survey of the river below the effluent outfall was made to study the fate of this waste. The results showed that a significant amount of the Cs^{137} , which is the principal radioactive constituent of effluent, is removed from solution in the river water and absorbed on the river bed. This effectively reduces the concentration of this radionuclide in drinking water derived from the river. Enhanced activity on the river bed persists for many miles below the outfall, but is not sufficient to raise radiation levels in air significantly above background at any point. Concentrations of Cs^{137} in both weed and fish sampled below the outfall are greater than in similar samples collected above, but are well within the permissible levels. (auth)

29536 (AHSR(RP)-R-9) A CATALOGUE OF AVAILABLE WHOLE BODY PROTECTIVE CLOTHING. R. P. Rowlands, comp. (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch. Radiological Protection Div., Harwell, Berks, England). June 1961. 72p.

Brief descriptions are given of the designs and fabricating materials of each of the whole-body pressurized or unpressurized impermeable suits in regular use within the Authority. (D.L.C.)

29537 (CRT-1029) NON-EQUILIBRIUM CONCENTRATIONS OF RADON DAUGHTERS IN A VENTILATED MINE. E. W. Vogt, C. G. Stewart, and S. D. Simpson (Atomic Energy of Canada Ltd., Chalk River, Ont.). June 1961. 20p. (AECL-1296).

The relative concentrations of radon daughters in a ventilated mine atmosphere are calculated for use in estimating airborne radiation hazards in a uranium mine. Various models describing the ventilation process are developed and calculated to show that the departure of the concentrations from the equilibrium values which obtain in an unventilated atmosphere is approximately independent of the mode of ventilation. A single parameter, the ventilation rate can be used to describe the departure from equilibrium. (auth)

29538 (HW-68533) RADIOLOGICAL CHEMISTRY OPERATION ANNUAL REPORT, JANUARY-DECEMBER 1960. J. M. Nielsen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 15, 1961. Contract AT(45-1)-1350. 75p.

Activities are discussed for research in analytical and counting methods, environmental and reactor studies, and radiation chemistry. Individual studies are included for: a bioassay procedure for measuring Np^{237} ; analytical applications of electroanalysis; detection of trace amounts of radioactivity in chemical reagents and other materials; background measurements in iron and lead shields; background reduction in gamma spectrometry with anticoincidence shielding; radiochemical analysis of Willapa Bay oysters; production of high-purity Np^{239} by resonance neutron activation; cross sections for the threshold reaction, $\text{S}^{32}(\text{n,p})\text{P}^{32}$; source of P^{32} and Sc^{46} in Hanford reactor effluent water; chemical forms of radioactive ions in Hanford reactor effluent water; radioisotope concentration in Hanford reactor effluent water from zirconium process tubes; the effectiveness of high-coagulant feed on reduction of

Hanford reactor effluent radioisotope concentrations; radiation sensitivities of metabolic products in dilute aqueous solutions; erioglaucine as a chemical dosimeter; radiation chemistry of Agar; protolysis and hydrolysis constants for trisulfonated triphenylmethane dyes; and membrane electrode cell for the determination of dissolved oxygen. (B.O.G.)

29539 (LAMS-2602) HEALTH PROBLEMS ASSOCIATED WITH THE ACCELERATION OF TRITONS IN A 2.5 MEV VAN DE GRAAFF. Morris J. Engelke (Los Alamos Scientific Lab., N. Mex.). July 1961. Contract W-7405-eng-36. 15p.

Some of the health problems associated with the acceleration of tritons in a 2.5-Mev Van de Graaff are enumerated. In the course of years of operation many procedures in the handling of tritium and tritium-contaminated components were accumulated. A summary of these experiences is presented. While there are potential dangers associated with tritium acceleration, reasonable precaution was found to prevent serious personnel exposures. (auth)

29540 (NP-10553) THE HAZARDS AND CHARACTERISTICS OF PLUTONIUM AND URANIUM CONTAMINATION. (Defense Atomic Support Agency. Field Command, Albuquerque, N. Mex.). Mar. 10, 1961. 44p.

A publication is presented for use as an unclassified ready reference concerning Pu and U contamination. It is noted that the contents are neither exhaustive nor all-inclusive. (J.R.D.)

29541 (NP-10664) SITE EMERGENCY CONTROL. Authority Code No. E. 3.1. (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, Risley, Lancs, England). Dec. 1960. 6p.

Codes are presented outlining the responsibilities involved and the procedures for pre-emergency planning, external liaison, and emergency reporting. (D.L.C.)

29542 (NP-10714) FINAL SAFEGUARDS REPORT FOR ARMED FORCES RADIOBIOLOGY RESEARCH INSTITUTE. (National Naval Medical Center, Bethesda, Md.). Sept. 1961. 391p.

An exhaustive safeguards report is presented for the DASA-TRIGA research reactor which is to be used for the production of intense fluxes of ionizing radiation for research into the field of radiobiology as well as for training, research, and isotope production. The report includes a site and facility description, reactor design, nuclear analysis, hazards analysis, and procedures. (D.L.C.)

29543 (NRL-5658) ATMOSPHERIC RADIOACTIVITY AT KODIAK AND WALES, ALASKA. L. B. Lockhart, Jr. (Naval Research Lab., Washington, D. C.). June 9, 1961. 18p.

The concentrations of radioactivity in the air in Alaska were documented from data collected by NRL air-monitor equipment operated at Kodiak (1950 to 1960) and Wales (1953 to 1959). Seasonal variations in the short-lived natural radioactive components of the air were observed at both sites while variations in the fission product concentration were directly related to periods of nuclear testing, particularly by the Soviet Union. Concentrations of both natural and fission product activities were generally much lower than those found along the eastern seaboard of the United States. The possible use of thorium B as a tracer for short-term atmospheric processes is pointed out. (auth)

29544 (ORNL-3100) DECONTAMINATION OF CELLS 6 AND 7, BUILDING 3019, FOLLOWING PLUTONIUM-RELEASE INCIDENT. J. R. Parrott (Oak Ridge National

Lab., Tenn.). Sept. 11, 1961. Contract W-7405-eng-26. 51p.

As a result of the evaporation explosion in the Radiochemical Processing Pilot Plant on Nov. 20, 1959, two cells were contaminated with plutonium to a transferable level of 10^8 d/m/100 sq cm. The area involved measures 40 by 20 by 27 ft high with a total surface area, including equipment, of 10,000 sq ft. The cells were decontaminated by a factor of 1000 in five months by removing loose equipment, debris, and shielding blocks and flushing with 430,600 liters of various decontaminating reagents. The remaining contamination ($10^4 - 10^5$ d/m/100 sq cm) was fixed to the surface with three coats of paint. The general beta-gamma radiation background was decreased from 2000 to 30 mr/hr and the long-lived alpha contamination in the air was reduced from 2×10^{-10} to 8×10^{-13} μ c/cc. Approximately 141 g of plutonium was flushed from the cell surfaces. The total direct effort expended was 3000 man-hr including 250 entries into the cell, 175 of which were made in plastic air suits. There were no overexposures from beta-gamma radiation and no detectable increase in the body burden of plutonium of any individual involved. (auth)

29545 (PWAC-347) LIQUID METAL FIRE CONTROL, JUNE 15, 1961. T. P. McGrath and E. E. VanBrunt, Jr. (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). July 1, 1961. Contract AT(11-1)-229. 84p.

The feasibility of a drain and sump system as a method for controlling burning liquid metal without the use of an extinguishing agent was demonstrated in tests performed with lithium and NaK. The effectiveness of Met-L-X (NaCl plus protective coating agent) in controlling and eventually extinguishing lithium fires on metal floors when the depth of lithium was approximately one-half inch was also demonstrated. A large fraction of the liquid metal discharged on to the drainage system flowed to the sump when the floor and V-trough were sloped seven degrees. In three tests with lithium during which a fire occurred, 75 to 80% of the burning lithium ran into the sump and extinguished itself. One test was made with floor and V-trough slopes of five and three degrees, respectively. With this configuration the flow of lithium was very poor and no lithium was collected in the sump. In the two NaK tests performed (floor and V-trough sloped seven degrees), 40 and 55% of the NaK ran into the sump where it was extinguished. It was assumed that with fires involving large amounts of liquid metal, even greater percentages of liquid metal would be collected and extinguished provided a minimum floor and V-trough slope of seven degrees was used. One-eighth inch and one-quarter inch thick mild steel floors proved satisfactory for use in the drainage system. The burning liquid metal did not damage the floor and the slight warpage of the plates was not great enough to impede the flow of the liquid metal. Ignition of the liquid metal in air apparently depended to a large degree on the amount of spattering of the metal. More rapid ignition was observed when extensive spattering occurred. The NaK, which produced a greater degree of spattering than the lithium, burned more readily. High temperature insulation (Johns-Manville "Superex" and 85 percent magnesia) was completely destroyed when exposed to a stream of 1200F lithium. When lithium or NaK at ambient temperature was mixed with each of the three ambient organic materials, JP-5 jet fuel (MIL-J-5624E), lubricating oil (MIL-L-7808) and monoisopropylbiphenyl (MIPB), the only reaction observed was the very slow formation of gas bubbles on the surface of the NaK as it was added to the JP-5 and lubricating oil. When the organics at 200F were added to the

lithium or NaK at ambient temperature the results were essentially the same as in the previous tests with the following exceptions: gas bubbles were formed when MIPB was added to the NaK; also, there was no visible reaction between the lubricating oil and NaK. When organic materials at 200F were added to burning lithium or NaK, typical oil fires resulted on the surfaces of the metals. Various extinguishing agents were applied to these fires to test their effectiveness. Dry Chemical (NaHCO₃ plus a drying agent to provide a free flowing material) effectively extinguished lithium-JP-5, NaK-JP-5, and NaK-MIPB fires. Dry Chemical was not effective on lithium and NaK lube oil fires, the former because of an apparent lube oil-lithium reaction, Met-L-X also proved ineffective on a lithium-lube oil fire in the one test made. However, Dry Chemical followed immediately by Met-L-X did extinguish a lithium-lube oil fire. Application of Dry Chemical to burning lithium alone caused the fire to increase in intensity. It was concluded that Dry Chemical should not be used on lithium fires. A test of Dry Chemical on burning NaK was not run. In facilities where both liquid metal and organics and their attendant fire hazards are present at the same time, fire protection systems should be provided to handle both types of fires. It was not determined whether a single piped system using a mixture of Dry Chemical and Met-L-X would operate satisfactorily. (auth)

29546 (SC-4609(RR)) ENVIRONMENTAL BETA-GAMMA RADIOACTIVITY IN AIR AT SANDIA LABORATORY, SECOND QUARTER 1961. R. E. Womelsdoff and J. E. Baker (Sandia Corp., Albuquerque, N. Mex.). July 1961. 12p.

The gross beta-gamma radioactivity (expressed as micromicrocuries per cubic centimeter of air) of air samples is reported. (auth)

29547 (SC-4628(M)) RADIOACTIVE ENVIRONMENTAL SURVEY AT SANDIA CORPORATION. William D. Burnett, Donald J. Coleman, Robert G. Elsbrock, and Robert J. Everett (Sandia Corp., Albuquerque, N. Mex.). May 18, 1961. 34p.

The collection, analyses, and evaluation of soil, vegetation, and water samples from the local environment surrounding Sandia Corporation Area V: the city of Albuquerque, Bernalillo and Sandoval Counties, New Mexico. The program was primarily to establish background radiation levels for selected radioactive isotopes prior to the start-up of Sandia Corporation's Pulsed Reactor Facility and Engineering Reactor Facility. (auth)

29548 (TID-13696) HAZARDS SUMMARY REPORT, ADVANCED TEST REACTOR CRITICAL EXPERIMENT AT LYNCHBURG, VIRGINIA. A. L. MacKinney (Babcock and Wilcox Co. Critical Experiment Lab., Lynchburg, Va.). Aug. 1961. Contract AT(10-1)-1075. 74p.

The proposed critical experiment for the Advanced Test Reactor is planned to aid in the design phase of the reactor. The critical experiment is a close nuclear mock-up of the present core design, with flexibility to study the effects of changes in certain areas. The design and construction features of the critical experiment as well as proposed operating procedures and program are described. Using conservative assumptions, the maximum credible accident was evaluated; for the maximum credible reactivity insertion rate, core melting was not expected to occur, even in the event of failure of the reactor safety system. The direct radiation and environmental hazards are shown to be small, and operation of the reactor does not offer any undue hazard to the public health and safety. (auth)

29549 (AEC-tr-4463) ON THE METHOD OF ESTIMATION OF THE POPULATION DOSE, POPULATION, AND

SURFACE AREA COVERED BY THE DIFFUSION OF RADIOACTIVE CLOUDS. Yasushi Nishiwaki. Translated from J. At. Energy Soc. Japan, 1: 1-8(1959). 20p.

Estimation of the radiation dose to people surrounding a radiation control area due to the diffusion of radioactive clouds of gas or particles discharged from reactors or other facilities in a nuclear accident or under normal operating conditions is discussed. The method suggested is based on O. G. Sutton's basic formula for continuous point sources. The distribution of population density in the area in question, estimation of area and population by elliptic approximation, and a comparison between the approximation formula and its graphic-integration value are discussed. (M.C.G.)

29550 (AERE-Trans-871) LATENT DANGER INHERENT IN A HYDROGEN LIQUEFIER INSTALLATION. R. Spoendlin (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). Translated by K. R. Poole for U.K.A.E.A., Atomic Energy Research Establishment, Harwell, Berks, Eng. from report DPC.IS/60-641/RS/MBR, Nov. 9, 1959. 9p.

A survey is presented of the dangers which may arise in a hydrogen liquefier apparatus, and includes discussions of past accidents caused by liquid hydrogen itself, and the presence of hydrogen gas in the liquefier. Conclusions are derived regarding the operational safety of a hydrogen liquefier. (B.O.G.)

29551 (JPRS-9896) ORGANIZATION OF SANITARY CONTROL IN THE USE OF RADIOACTIVE SUBSTANCES AND OVERALL SOURCES OF IONIZING RADIATION IN THE NATIONAL ECONOMY OF THE UNION OF SOVIET SOCIALIST REPUBLICS. P. I. Moiseitsev. Translated from Gigiena i Sanit., 26: No. 5, 51-5(1961). 9p.

Sanitary control of radiation safety maintenance in the various branches of the national economy where radioactive substances and sources of ionizing radiations are used is discussed. The practical work of the sanitary-epidemiological stations, divisions, and groups for radiation safety consists of the 3 following tasks: realization of a preventive sanitary control, effectuation of a current sanitary control, and control of the radioactive state of the environments. Sanitary inspections of plants, institutions, and laboratories are discussed. The work of the various radiological safety groups is discussed. (M.C.G.)

29552 (JPRS-9925) NEW RULES FOR RADIATION SAFETY. B. M. Zlobinskii (Zlobinskiy). Translated from Bezopasnost Truda v Prom., 5: No. 4, 37-8(Apr. 1961). 6p.

New rules for radiation safety which establish the principles required for the safe execution of work with radioactive substances and sources of ionizing radiation are discussed. These rules are compulsory for designing, construction, remodeling, and operation and apply to every organization that uses, transports, or stores radioactive material. New maximum permissible levels of radiation were established. (M.C.G.)

29553 (JPRS-10068) STUDY OF THE RADIOACTIVE BACKGROUND OF AEROSOLS IN THE ATMOSPHERIC AIR OF THE CITY OF FRUNZE. V. E. (Ye.) Sinel'nikov and K. M. Veitsman (Veytsman). Translated from Gigiena i Sanit., 26: No. 6, 91-2(1961). 7p.

Results are presented for determinations of the alpha and beta activity of radioactive aerosols in the air of Frunze, USSR. The average half-life period of the aerosols was determined to be 35 to 50 min and is ascribed to disintegration products of radon and thoron. The average concentration of both alpha and beta activities in the aerosols is

$\sim 5 \times 10^{-14}$ curies/liter. A correlation was found between the total dust content of the air and the beta activity of the aerosols. A determination of the activity of long-lived aerosols is reported. (D.L.C.)

29554 THE EFFECT OF IONIZING RADIATION ON THE CORROSIVE BEHAVIOR OF METALS IN CARBON TETRACHLORIDE. A. V. Byalobzhetskii and V. N. Lukinskaya. *Atomnaya Energ.*, 11: 170-6 (Aug. 1961). (In Russian)

It is established that under the effect of radiation CCl_4 is decomposed, yielding free Cl which in turn forms HCl if moisture is present in the system. Accordingly it may be assumed that metals immersed in CCl_4 containing some moisture will be more strongly corroded if the system is exposed to radiation. This was studied by exposing various metallic samples placed in a tightly closed glass cell containing CCl_4 to an integrated x-ray dose of $0.8 \cdot 10^{22}$ ev at 25°C for 10 hours. Tests showed that 99% of the radiation was absorbed in the 5-cm liquid layer which thus protects the sample from direct radiation. The corrosion rate was calculated on the basis of the weight loss suffered by the sample. It was found that the corrosion of all the metals tested, Ti, Al, Zr, stainless steel, Monel and Cu, was increased as a result of exposure to radiation. Presence of water enhanced this effect by its products of radiolysis but addition of water beyond its solubility in CCl_4 resulted in the reduction of the corrosion rate as a result of the diffusion of the Cl^- ions in aqueous phase. No metallorganic compounds were found, accordingly the direct attack of CCl_4 on the metals must be excluded as the cause of the corrosion. (TTT)

29555 MINIMUM VALUES IN RADIATION-MEASUREMENT TECHNOLOGY AND THEIR DEPENDENCE ON ZERO EFFECT. Rolf Plesch (Siemens und Halske A. G., Karlsruhe, Ger.). *Atompraxis*, 7: 300-4 (Aug. 1961). (In German)

An optimal utilization of radiation-measurement facilities may make it desirable to work with a minimum total measurement time at a given accuracy, and with maximum accuracy at a given measurement time. Furthermore, safety considerations may make it desirable to take the activity of the preparation as a minimum, with a given measurement time and accuracy. These three minimum conditions are combined in the equation $\epsilon \sqrt{T} (\sqrt{I_g} - \sqrt{I_0}) - 100 = 0$. For dividing up the total measurement time, the simple equation $T_0 : T_g = \sqrt{I_0} : \sqrt{I_g}$ is used. The average percentages of error for the parameters T , ϵ and I_g are given. The three minimum values can be further reduced, singly, all together, or in combination, by reducing the zero effect I_0 . The influence of the zero effect is calculated and shown in three diagrams; by using these it is easy to ascertain which improvement in measurement technique is possible by reducing the zero effect, and to which extent the zero effect must be reduced in order to achieve a given improvement. Examples are included to explain the use of the formulas and diagrams. (tr-auth)

29556 GAMMA IRRADIATION FACILITIES AND CONTINUOUS DOSIMETRY. R. Eymery and Ch. Rispal. *Bull. inform. sci. et tech.* (Paris), No. 51, 76-9 (May 1961). (In French)

The characteristics of gamma irradiators, with consideration of the self-absorption and the relative geometry, are briefly described. The different methods for continuous dosimetry of radiation sources are classified, and the industrially usable radioisotopes are given. A brief discussion is given of the intense sources of the C.E.A. (J.S.R.)

29557 CONTROL OF THE DISTRIBUTION AND UTILIZATION OF ARTIFICIAL RADIOELEMENTS. L. E. Huet. *Bull. inform. sci. et tech.* (Paris), No. 51, 109-16 (May 1961). (In French)

In order to protect the health of users of artificial radioisotopes and of the population, their distribution and utilization is rigidly controlled in France and its overseas dependencies. The regulations for procurement and utilization are tabulated. (J.S.R.)

29558 THE PHARMACEUTICAL CONTROL OF ARTIFICIAL RADIOELEMENTS FOR MEDICAL PURPOSES. Y. Cohen. *Bull. inform. sci. et tech.* (Paris), No. 51, 117-19 (May 1961). (In French)

Radioisotopes and labeled compounds destined for diagnostic or therapeutic usage must satisfy very severe standards of purity. The codified physical, chemical, and biological controls are listed. (J.S.R.)

29559 TWO YEARS OF MONITORING THE RADIOACTIVITY OF THE RHONE AND THE PHREATIC LEVEL. C. Bizollon, Pr. Agrégé Moret, and Pr. Berger (Faculté de Médecine, Lyon). *Bull. Inst. Natl. Hyg.*, 16: 643-61 (May-June 1961). (In French)

The total β activity of the Rhone water, sampled upstream from the point of release of radioactive wastes, has been determined for two years. The values obtained are very close to each other and very weak (of the order of 4 pc/l). It can thus be said that the natural radioactivity of Rhone water is low and constant. When radioactive wastes are released into the Rhone, these are detected. The β activity of the river increases from the release point, slowly at first then more rapidly. It passes through a maximum (1150 km downstream) and then progressively decreases. This type of curve is found both for the β activity of dissolved substances and of suspended substances. The sampling made 1150 km downstream appears to be the most representative. With respect to the water supplies of towns located on the Rhone, downstream from the Centre de Marcou, they can be classified into two categories: water supply whose source is the phreatic level of the Rhone and water supply coming from the Rhone. The total β radioactivity of the first, originally low, has not increased in two years in spite of the release of radioactive wastes into the Rhone. For the latter, it appears the release affects the β activity, but it is always below the maximum permissible concentration for populations (MPCP). The drinking water of the towns of Tarascan and Villeneuve-lès-Avignon has a β activity above the MPCP. This activity appears to originate from natural potassium in the water. (tr-auth)

29560 METHODS OF CONTROL AND THE DECONTAMINATION OF RADIOACTIVE AEROSOL AND GAS. A. Facchini and M. Mandelli Bettoni (Istituto di Fisica del Politecnico, Milan). *Energia elettrica*, 37: No. 1, 14p. (1960). (In Italian)

The principal methods for the control and decontamination of radioactive aerosols and gases, differentiated according to the origin of the aerosol and the contaminants, are examined. (tr-auth)

29561 SOME PRESSING PROBLEMS OF DOSIMETRY IN CLINICAL RADIOLOGY. A. N. Krongauz. *Med. Radiol.*, 6: No. 6, 78-82 (June 1961). (In Russian)

The principal task of dosimetry in clinical radiology is the elucidation of distribution of absorbed doses in individual organs within the irradiated organism and in the body as a whole. For this purpose use is made either of estimation methods, or measurement of doses in the air with recalculation in accordance with tables in units of absorbed doses and integrally absorbed doses. (auth)

29562 RADIATION CONTROL IN PUBLIC HEALTH. Russell H. Morgan (Johns Hopkins Hospital, Baltimore). Public Health Repts. (U. S.), 76: 571-81(July 1961). Public health programs in the field of radiation control in the United States are reviewed. Environmental exposure hazards, biological effects of radiation, standard permissible limits of radiation exposure, and training programs in radiation protection are discussed. (C.H.)

29563 CONTROL OF COMMON RADIATION HAZARDS IN NEW YORK CITY. Leona Baumbartner (Commissioner of Health for New York) and Hanson Blatz. Public Health Repts. (U. S.), 76: 583-90(July 1961).

The extensive radiation control system adopted by New York City is described. The program is interdepartmental, with major responsibility vested in the health department. A new section of the New York City Health Code requires registration of every source of radiation in the city and notification of hazardous shipments of radiation materials, of all newly installed radiation installations, and of all accidents, incidents, and overexposures. Emphasis is placed on helping physicians and dentists to reduce to a minimum the radiation dose to patients from x-ray equipment. Steps have also been taken to control the use of radium, to deal with problems involving radioactive isotopes, the transportation of radioactive materials, the disposal of radioactive wastes, and problems involving fallout. (C.H.)

29564 CALCULATION OF THE DOSE DISTRIBUTION IN CIRCUMAXIAL ROTATION THERAPY WITH 280-kvp RADIATION. H. F. Batho and M. E. J. Young (British Columbia Cancer Inst., Vancouver). Radiology, 77: 458-64 (Sept. 1961).

The minimal modifications in a previously devised method were determined in order to make it applicable to rotation techniques with conventional deep therapy x rays. The experimental dose distribution was determined in a water phantom due to circumaxial rotation with given irradiation conditions, and the distribution was then compared with the distributions calculated on different assumptions or approximations. A single isodose chart was not used for each field size, regardless of the focus-skin distance, but acceptable agreement between calculated and experimental distributions was obtained with only a limited number of isodose charts. (P.C.H.)

29565 NEW RULES FOR PERSONNEL HANDLING RADIOACTIVE MATERIALS AND IONIZING RADIATION. S. S. Gurvits and E. D. Chistov (All-Union Central

Scientific-Research Inst. of Labor Protection, USSR). Zavodskaya Lab., 27: 626-8(1961). (In Russian)

A new set of rules is given for personnel handling radioactive materials. Classifications of radioactive materials and permissible doses are tabulated. (R.V.J.)

29566 PROTECTIVE CONSTRUCTION IN A NUCLEAR AGE. Proceedings of the Second Protective Construction Symposium, March 24-26, 1959. Volumes 1 and 2. J. J. O'Sullivan, ed. New York, The Macmillan Company, 1961. 898p. \$25.00.

This paper was previously abstracted and appears in NSA, Vol. 14, abstract no. 8518.

29567 RADIOLOGICAL HEALTH DATA MONTHLY REPORT, SEPTEMBER 1961. Volume II, No. 9. (Public Health Service, Washington, D. C.). 37p.

Data are given on radioactivity levels in air, milk, food other than milk, and water. Miscellaneous data are also included on external gamma activity, radioactivity in animal foods, Sr⁹⁰ fall-out, and radiation levels at Atomic Energy installations. (J.R.D.)

29568 NUCLEAR POWER SAFETY ECONOMICS. An Analysis of Health and Safety Costs Associated With the Design, Construction and Operation of Nuclear Power Reactors. Saul J. Harris. New York, Pilot Books, 1961. 86p. \$3.00.

An analysis of health and safety costs associated with the design, construction, and operation of nuclear power reactors is given. The engineering considerations for safety and the costs of engineering components for nuclear power reactors are limited to the pressurized water type. The per cent of the total construction costs which may be attributable to health and safety could not be clearly fixed but ranged from a minimum of 20% upward to perhaps in the order of 65%. (N.W.R.)

29569 UBERWACHUNG DER RADIOAKTIVITÄT IN ABWASSER UND ABLUFT. KERntechnische Reihe Heft 1. (Monitoring of Radioactivity in Waste Water and Off-gas. Nuclear Technology Series No. 1). Hans Klefer and Rupprecht Maushart. Stuttgart, B. G. Teubner Verlagsgesellschaft, 1961. 112p.

Methods and equipment for monitoring radioactivity in water and air are described. Topics covered include permissible concentrations of radioactive materials in water and air, basic equipment for measuring activity, measurement of activity in air, and application of radioactivity measurements. (M.C.G.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

29570 (TID-6613(Suppl. 1)) RADIOISOTOPES IN WORLD INDUSTRY. ABSTRACTS OF SELECTED FOREIGN LITERATURE. (Office of Isotopes Development, AEC). June 1961. 123p.

The 529 abstracts included in the supplement are to books and U. S. and foreign journals published from 1957 to December 1960. The abstracts are grouped by subject and subgrouped by country in order to facilitate reference. Author and country indexes are also included. (P.C.H.)

29571 (AEC-tr-4544) SELECTED ARTICLES FROM THE PROCEEDINGS OF THE ALL-UNION SCIENTIFIC CONFERENCE ON THE APPLICATION OF RADIOACTIVE AND STABLE ISOTOPES AND RADIATION IN THE NATIONAL ECONOMY AND SCIENCE, MOSCOW, APRIL 4-12, 1957. PRODUCTION OF ISOTOPES: LARGE GAMMA-RAY INSTALLATIONS: RADIOMETRY AND DOSIMETRY. Translation of Trudy Vsesoyuz. Nauch.-Tekh. Konf. po Primenen. Radioaktiv. i Stabil. Izotopov i Izluchenii v Narod. Khoz. i Nauke, Moscow, 1957 (1958). Poluchenie Izotopov, Moshchnye Gamma-Ustanovki, Radiometriya i Dozimetriya, p.169-209. 48p.

Seven papers are included which were presented on the topics of gamma sources and irradiation facilities at the 1957 Russian conference on the applications of radioactive and stable isotopes and radiation. Separate abstracts have been prepared for all seven papers. (D.L.C.)

29572 (AEC-tr-4544(p.1-7)) TASKS AND TRENDS IN THE FIELD OF POWERFUL GAMMA-INSTALLATION CONSTRUCTION. V. I. Sinitsyn. Translated from Trudy Vsesoyuz. Nauch.-Tekh. Konf. po Primenen. Radioaktiv. i Stabil. Izotopov i Izluchenii v Narod. Khoz. i Nauke, Moscow, 1957 (1958). Poluchenie Izotopov, Moshchnye Gamma-Ustanovki, Radiometriya i Dozimetriya, p.169-74.

A brief review is presented on powerful gamma source installations and their application. Some of the installations already in existence over the world are discussed. Requirements and problems encountered in the construction of powerful gamma sources are discussed. (D.L.C.)

29573 (AEC-tr-4544(p.8-15)) PRINCIPLES AND TECHNIQUES IN THE USE OF RADIOACTIVE ISOTOPES AS POWERFUL GAMMA SOURCES IN RADIOBIOLOGY AND MEDICINE. A. V. Bibergal, U. Ya. Margulis, and V. G. Khrushchev. Translated from Trudy Vsesoyuz. Nauch.-Tekh. Konf. po Primenen. Radioaktiv. i Stabil. Izotopov i Izluchenii v Narod. Khoz. i Nauke, Moscow, 1957 (1958). Poluchenie Izotopov, Moshchnye Gamma-Ustanovki, Radiometriya i Dozimetriya, p.175-81.

A review is presented on the use of radioisotopes as gamma sources for the irradiation of relatively large biological objects (on experimental and industrial scales) and of microscopic biological objects (usually, large doses are required), and for therapy. Installations EGO-1, EGO-2, EGO-20, and GUBE, which were constructed for the experimental irradiation of animals and plants, are described. (D.L.C.)

29574 (AEC-tr-4544(p.16-24)) INSTALLATION FOR RADIATION CHEMISTRY RESEARCH WITH A Co^{60} GAMMA RADIATION SOURCE WITH AN ACTIVITY OF 21,000 GRAM-EQUIVALENTS OF RADIUM. A. Kh. Breger, V. A.

Belynskii, V. L. Karpov, S. D. Prokudin, and V. B. Osipov. Translated from Trudy Vsesoyuz. Nauch.-Tekh. Konf. po Primenen. Radioaktiv. i Stabil. Izotopov i Izluchenii v Narod. Khoz. i Nauke, Moscow, 1957 (1958). Poluchenie Izotopov, Moshchnye Gamma-Ustanovki, Radiometriya i Dozimetriya, p.182-8.

Installation K-20000 was constructed to facilitate radiation chemistry research. K-20000 gives a dose rate of 1,200 r/sec in a volume of 0.4 liter and 100 r/sec in a volume of 100 liters; the total volume of the operational chamber is 300 liters. The Co^{60} source possesses an activity of 21,000 gram-equivalents of radium. (D.L.C.)

29575 (AEC-tr-4544(p.25-8)) THE COBALT EMITTER LABORATORY. A. V. Babushkin, I. V. Voznesenskaya, N. G. Zhirov, V. I. Zatulovskii, and Yu. L. Khmel'nitskii. Translated from Trudy Vsesoyuz. Nauch.-Tekh. Konf. po Primenen. Radioaktiv. i Stabil. Izotopov i Izluchenii v Narod. Khoz. i Nauke, Moscow, 1957 (1958). Poluchenie Izotopov, Moshchnye Gamma-Ustanovki, Radiometriya i Dozimetriya, p.189-92.

A cobalt laboratory for research on radiation chemistry applications in petroleum processing and petroleum chemistry is described. The laboratory building has three booths, two for sources of activity up to 800 gram-equivalents of radium and one for a source of activity from 10,000 to 16,000 gram-equivalents of radium. The sources are situated in underground lead vessels, and samples are lowered into the vessels for irradiation. (D.L.C.)

29576 (AEC-tr-4544(p.29-35)) THE SOURCES OF IONIZING EMISSIONS FOR WORK IN RADIATION CHEMISTRY. V. I. Zatulovskii. Translated from Trudy Vsesoyuz. Nauch.-Tekh. Konf. po Primenen. Radioaktiv. i Stabil. Izotopov i Izluchenii v Narod. Khoz. i Nauke, Moscow, 1957 (1958). Poluchenie Izotopov, Moshchnye Gamma-Ustanovki, Radiometriya i Dozimetriya, p.193-9.

The advantages and disadvantages of x-ray equipment for radiation chemistry studies are outlined, and requirements are given for cobalt source installations. The design of GOP-400, an installation with a Co^{60} source of activity of 400 gram-equivalents of radium, is discussed briefly. The problems encountered in designing two installations for irradiating objects of volumes 120 cm^3 and 1 liter are treated; the activities are, respectively, 2.5 and 10 kilogram-equivalents of radium. The adaption of the 2.5 kilogram-equivalent design to an existing building is discussed. (D.L.C.)

29577 (AEC-tr-4544(p.36-41)) THE DESIGN OF AN EXPERIMENTAL SEMI-INDUSTRIAL INSTALLATION FOR RADIATION DISINFESTATION OF GRAIN. E. S. Pertsovskii, A. V. Bibergal, and U. Ya. Margulis. Translated from Trudy Vsesoyuz. Nauch.-Tekh. Konf. po Primenen. Radioaktiv. i Stabil. Izotopov i Izluchenii v Narod. Khoz. i Nauke, Moscow, 1957 (1958). Poluchenie Izotopov, Moshchnye Gamma-Ustanovki, Radiometriya i Dozimetriya, p.200-5.

The design of an experimental installation for research on the efficiency of radiation disinfestation of grain is described. Co^{60} is to be used as the source, and the grain will be moved into the radiation field by a conveyor belt

in a tube. The outlook for radiation disinfection is discussed. (D.L.C.)

29578 (AEC-tr-4544(p.42-6)) **GAMMA EMITTERS IN THE PRESERVATION OF FOOD PRODUCTS.** N. D. Chernyaev. Translated from Trudy Vsesoyuz. Nauch.-Tekh. Konf. po Primenen. Radioaktiv. i Stabil. Izotopov i Izlucheni v Narod. Khoz. i Nauke, Moscow, 1957 (1958). Poluchenie Izotopov, Moshchnye Gamma-Ustanovki, Radiometriya i Dozimetriya, p.206-9.

The applications of radiation to food treatment and the various types of radiation sources usable for this purpose are outlined. The design of the powerful gamma source installation developed by the VNIKOP for treatment of food products is described in detail, and two similar USA installations are described briefly. (D.L.C.)

29579 **THE DEPARTMENT OF RADIOELEMENTS.** C. Fisher. Bull. inform. sci. et tech. (Paris), No. 51, 3-5(May 1961). (In French)

The Service des Radioelements has the general mission of the production of artificial radioelements and labeled molecules, as well as the development of their industrial uses. It also controls the utilization of radiation sources throughout the country. The various activities of the Service des Radioelements are reviewed in separate articles. (J.S.R.)

29580 **ACTIVITIES OF THE SECTION FOR THE PREPARATION OF RADIOELEMENTS.** R. Henry. Bull. inform. sci. et tech. (Paris), No. 51, 6-8(May 1961). (In French)

The Section for the Preparation of Radioelements has charge of the production of radioisotopes in reactors. The activities of the section cover all work from the irradiation of the samples up to the synthesis of special compounds. The structure, results, and the problems of the Section are briefly described. (J.S.R.)

29581 **ACTIVITIES OF THE SECTION OF LABELED MOLECULES.** L. Pichat. Bull. inform. sci. et tech. (Paris), No. 51, 9-11(May 1961). (In French)

Since the beginning of 1955 the activities of the Section of Labeled Molecules has been devoted exclusively to the preparation of organic compounds labeled with C^{14} , T , S^{35} , N^{15} , and D for pharmaceutical and medical uses. (J.S.R.)

29582 **ACTIVITIES OF THE SECTION FOR THE SEPARATION OF FISSION PRODUCTS.** A. Raggenbass. Bull. inform. sci. et tech. (Paris), No. 51, 12-13(May 1961). (In French)

The Section for the Separation of Fission Products is composed of three groups. One group studies problems at the laboratory level, the second group is in charge of chemical and radiochemical analyses, and the third group is studying the production of Sr sources and the installation for Cs^{137} production. The activities of this Section are briefly sketched. (J.S.R.)

29583 **ACTIVITIES OF THE SECTION FOR APPLICATIONS OF RADIOELEMENTS.** R. Cornuet. Bull. inform. sci. et tech. (Paris), No. 51, 14-16(May 1961). (In French)

The Section of Applications of Radioelements is divided into two groups, one based at Saclay and the other at Grenoble. The work of the Section includes studies on the industrial application of radioisotopes, activation analysis, and development of strong radiation sources. These activities are described in detail. (J.S.R.)

29584 **LABORATORY SPECIALIZED IN THE PRODUCTION OF RADIOELEMENTS.** C. Fisher. Bull. inform. sci. et tech. (Paris), No. 51, 17-21(May 1961). (In French)

France is second only to Great Britain in the production

of artificial radioisotopes in Europe. In 1959 construction was started on a hot laboratory for the production of radioisotopes. The laboratory is described and sketched. The interior equipment of the hot laboratory is indicated. (J.S.R.)

29585 **USE OF RADIOELEMENTS IN HYDROLOGY, IN THE LOCALIZATION OF LEAKS, AND IN THE MEASUREMENT OF FLOW.** R. Hours. Bull. inform. sci. et tech. (Paris), No. 51, 63-70(May 1961). (In French)

The range of utilization of radioisotopes in hydrology, leak detection, and flow measurements is reviewed. The methods and techniques are indicated. (J.S.R.)

29586 **RECENT APPLICATIONS OF RADIOACTIVE TRACERS.** G. Courtois. Bull. inform. sci. et tech. (Paris), No. 51, 71-5(May 1961). (In French)

The recent international trends in the use of radioactive tracers other than in hydrology and leak detection are briefly reviewed. Usage in wear and lubrication and metallurgy are mentioned. Some applications reported by the Section des Applications des Radioelements are described briefly. (J.S.R.)

29587 **INDUSTRIAL FUTURE OF IONIZING RADIATIONS.** F. Balestic, A. Lamm, and J. R. Puig. Bull. inform. sci. et tech. (Paris), No. 51, 80-5(May 1961). (In French)

The industrial applications of ionizing radiations appear to be most important in the fields of biology, physics, and chemistry. The prospects for use in biology and physics are mentioned, and radiation chemistry is discussed in some detail. The mechanism, chain reactions, modification of macromolecules, economics, industrial, semi-laboratory, and laboratory studies are described. (J.S.R.)

29588 **STATISTICS ON THE PRODUCTION AND UTILIZATION OF RADIOELEMENTS IN FRANCE.** L. Cassin. Bull. inform. sci. et tech. (Paris), No. 51, 105-8(May 1961). (In French)

Statistics are given to show the growth of the industrial utilization and production of radioisotopes in France. The types of radioisotopes exported and imported are tabulated. (J.S.R.)

29589 **RADIOACTIVE ISOTOPES IN SELECTING COOLING FLUIDS FOR GRINDING OPERATIONS.** S. N. Korchak. Stanki i Instr., No. 10, 26-8(1960).

To determine the metal quantity remaining on a grinding disk with the aid of W^{186} , tests were carried out with specimens of chromium-silicon steel. The specimens, both normalized and hardened, were ground with and without coolant. W^{186} was used because it emits only β radiation of low energy, dissolves easily and uniformly in iron, and has a high evaporation temperature. 0.16 kg of tungsten were added to the steel melt with a total activity of 13.5 mc. Since the molten metal weighed 50 kg, the W-content increased only by 0.0032%. The normalized specimens of the steel were heated up to 900°C with subsequent air-cooling, so that a pearlitic and ferritic structure with a hardness of HB 255-269 was obtained. The second group of specimens was oil-hardened at 800°C; these specimens were of a sorbite structure with a hardness of HB 555-600. The uniformity of radioactive tungsten distribution in steel was determined by measuring the activity of the individual specimens. The grinding conditions during the whole test period were constant: $v_{\text{disk}} = 39$ m/sec, $s_{\text{long}} = 9$ m/min, $t = 0.02$ m/double motion of table. A layer of metal 2 mm thick was removed during the grinding operations. Based on the counter characteristics, an operating voltage of the counter of $J = 1700$ v was selected. The pulses were read on a scaler. After the grinding the total activity of the

working layer and background were measured and corrected. The obtained results were averaged and corrected, taking into account the natural W^{188} decay. The calculations were effected according to the formula: $J_0 = J \exp [\ln 2 (t - t_0)/T]$, where J_0 = activity scaled on the first test day of a definite test series, J = average activity with corrections for the natural background, t = measuring date, t_0 = day of the beginning of test series, T = half life. The following cutting fluids were compared: 5% emulsion (a solution of emulsol in water), an emulsion of a 15% water solution of soda (1.5% NaNO_2 , 0.5% NaCO_3), No. 3 spindle oil, No. 3 spindle oil + 20% kerosene and sulfofrezol + 33% kerosene. For a comparison, grinding without cooling was carried out. The poorest result is obtained with the water emulsol solution, while the best result was obtained with an oil mixture (sulfofrezol and spindle oil) with kerosene. While different coolants produce a 300–400% difference in the amount of metal adhering to the working surface of the grinding disk, the described test method has the advantages of a comparative short time of investigation (10–12 working hours), and accurate results (rms deviation = 9.7%). (OTS)

29590 INFLUENCE OF γ -IRRADIATION ON SOME KINDS OF FRUITS AND ON CANNED FRUIT. Sh. M. Khatlashvili, T. V. Tsetskhladze, and L. I. Cherkezishvili. Trudy Inst. Fiz. Akad. Nauk Gruzin. S.S.R., 7: 119–26 (1960). (In Russian)

Some results of observations of changes in organoleptic properties of different fresh fruits, their juices, and canned fruit under the influence of γ irradiation (Co^{60}) are given. Irradiation of green persimmons to 1.5 million roentgen at 8500 r/hr leads to the gradual artificial ripening of the fruits. They do not gain any strange taste and are sweeter than the controls. During the same period of time the control green persimmons wither. Figs irradiated with 1.5 million roentgen are well conserved in hermetically closed jars for several weeks without changing their taste. Control figs go sour in 2 to 3 days under the same conditions. A wild plum is well conserved under γ irradiation during a month without any changes of its taste or appearance. The total dose reached 1 million roentgen per month. Control plums wither and rot after two or three days. Peaches irradiated in hermetically closed jars conserve their freshness, consistence, color, and taste for weeks when irradiated with 1.5 million roentgen at 8500 r/hr. With further storage the smell and taste of peaches changes sharply, but the appearance and consistence are conserved without any

changes for more than 7 months. The control peaches under the same conditions of storage rot after 4 to 5 days. Tangerines and lemons under irradiation acquire a strange taste beginning at 100 thousand roentgen. If they are irradiated with 750 thousand roentgen, the period of storage is doubled or tripled. The irradiated tangerines have the taste of boiled ones. Grapes under the influence of γ irradiation begin to spoil at 10000 r. Pink and black cherries are conserved for several weeks without changing their organoleptic properties if the dose is 750,000 r and the dose rate is 8500 r/hr. (auth)

29591 INVESTIGATION OF THE WEAR RESISTANCE OF DRAWING DIES BY MEANS OF RADIOACTIVE ISOTOPES. P. F. Groshev. Tsvetnye Metal., No. 10, 71–6 (1960).

Experiments were carried out with a drawing die made of carbide, weighing 3.5 g and used for drawing 0.6 mm copper wire. Prior to the experiments the finished dies were irradiated for 5 to 12 hours with slow neutrons. As a result, W^{187} , W^{185} , and Co^{60} formed. The most suitable was W^{187} since its half life is less than 24 hours. The required radioactivity was determined on the basis of preliminary calculations of the probable weight worn off the die, the value of which was 1.7×10^{-5} g. Thus, the required activity equaled 10.5 mc. The test rig for drawing enabled the drawn wire to be wound on a cylindrical drum with a gap of about 0.1 mm between the individual turns. The radioactive die was placed into a thick-walled steel housing, which can be shifted longitudinally relative to the drum by an amount corresponding to the pitch of the turns during each revolution. During the experiments, annealed copper wire with a strength of 23.4 kg/mm² and a relative elongation of 30 to 33% was drawn. The wear was determined on the basis of the activity of the wire samples measured immediately after drawing (with some check measurements carried out one day later). The wear of the die was determined as a function of the drawing speed for speeds between 14 and 1050 m/min. Three experiments were made with increasing speeds and three with decreasing speeds. The results are given in a table, and on the basis of the average value of all the experiments a graph was plotted, which shows that the wear drops quickly with increasing drawing speed. The relative values are 500 impulses/min for a drawing speed of 14 m/min, 260 impulses/min for a drawing speed of 216 m/min and 145 impulses/min for a drawing speed of 1050 m/min. (OTS)

ISOTOPE SEPARATION

29592 FUNDAMENTAL STUDIES ON THE ION EXCHANGE SEPARATION OF ISOTOPES. III. THE SEPARATION FACTOR OF THE ION-EXCHANGE PROCESS INVOLVING NITROGEN ISOTOPES IN THE SYSTEM OF $\text{NH}_3\text{-H}_2\text{O-ACETONE}$. Hidetake Kakihana (Tokyo Inst. of Tech.), Terunosuke Nomura, and Kiyoshi Kodaira. *J. At. Energy Soc. Japan*, 3: 519-21 (July 1961). (In Japanese)

The separation factors of nitrogen isotopes, $S_{14}^{15}(\text{N})$, for 0.1 M NH_3 in acetone-water mixtures were determined with differently cross-linked sulfonated polystyrene-divinylbenzene copolymers and synthetic inorganic exchanger (Ionite C). The values for $S_{14}^{15}(\text{N})$ lie between 1.023 and 1.034. The highest values 1.034 and 1.033 were obtained for 40% acetone with 55% DVB exchanger and for 80% acetone with Ionite C, respectively. From the data obtained for aqueous solutions, the equilibrium coefficient, $^{15}\text{K}_{\text{NH}_3}$, for the isotope exchange reaction between ammonia and ammonium ion, was calculated to be 1.027 at 20°C. (auth)

29593 PARTICLE TRAJECTORIES IN A GAS CENTRIFUGE. A. R. Kriebel (Stanford Research Inst., Menlo Park, Calif.). *J. Basic Eng.*, 83: 333-40 (Sept. 1961).

The motion of spherical particles injected into a cylinder of gas which rotates as a solid body is studied. The particle trajectory is expressed explicitly as a function of two dimensionless parameters; an injection-velocity parameter and an inertial parameter which is roughly the ratio of centrifugal force to drag force on the particle. The main results are the dependence on particle size of the time for particles to be centrifuged and of deposition angle. These results indicate performance limitations for an idealized cyclone separator and a centrifugal particle-size analyzer. Experimental data are presented for an air centrifuge which was designed to approximate the analytical flow model. Reasonably good agreement with theoretically predicted deposition angles was found for spherical glass beads and irregularly shaped chalk crystals, even to Reynolds numbers in excess of the Stokes flow regime for which the analysis applies. Particles as small as 2 microns may be classified with the present centrifuge configuration; however, by modification it might be used to classify particles in the submicron-size range. (auth)

29594 FRACTIONATION OF OXYGEN ISOTOPES BY THE DISTILLATION OF AZEOTROPIC SOLUTIONS. Lois Nash Kauder, W. Spindel, and E. U. Monse (Rutgers Univ., Newark N. J.). *J. Phys. Chem.*, 65: 1435-8 (Aug. 1961).

The possibility of using the exchange equilibrium $\text{H}_2\text{O}^{18}[\text{hydrated}] + \text{H}_2\text{O}^{18}[\text{solvent}] \rightleftharpoons \text{H}_2\text{O}^{18}[\text{hydrated}] + \text{H}_2\text{O}^{18}[\text{solvent}]$ for concentrating oxygen isotopes, by distilling azeotropic acid solutions, was investigated. Rayleigh distillations were carried out to determine the relative fractionation factors, α , for constant boiling HCl, HBr, and HNO_3 at several temperatures and pressures as compared to α' for water. Experiments were also run in a distillation column [65 cm long 13 cm i.d.] packed with tantalum helices, at atmospheric pressure and varying flow rates. With a flow rate of 38 ml/hr, water showed an over-all separation [depletion] of 1.41; 6.8 m HCl, 1.83; 10.9 m HBr, 1.90; and 31 m HNO_3 , 1.28. The single stage factor was calculated to be 1.007 for HCl at 110° and 1.007 for HBr at 126° as compared to a value of 1.004 for water at 100°. (auth)

29595 STUDY OF THE IONIC CONTAMINATION IN ELECTROMAGNETIC ISOTOPE SEPARATORS. APPLI-

CATION TO THE PRODUCTION OF ISOTOPES OF HIGH PURITY. J. Camplan, M. van Ments, and R. Bernas (Faculté des Sciences, Orsay, France). *J. phys. radium*, 22: Suppl. to No. 6, 91A-9A (June 1961). (In French)

The magnetic analysis of the ionic component of contamination in an electromagnetic isotope separator, is made through the use of the second stage of a double magnetic deflection isotope separator. The study shows that, besides gas scattering, a non-negligible part of contamination is due to low-energy ions. These phenomena account for a large part of the asymmetry of contamination which is very generally observed in isotope separators. Some methods for improving the performance of existing machines are suggested. (auth)

29596 ION SOURCE WITH SURFACE IONIZATION FOR SEPARATING ISOTOPES OF ALKALI ELEMENTS. V. I. Raiko, M. S. Ioffe, and V. S. Zolotarev. *Pribery i Tekh. Ekspt.*, 6: No. 1, 29-32 (Jan.-Feb. 1961). (In Russian)

Descriptions are given of the design and performance of an ion source with surface ionization for producing K and Rb ion beams in electromagnetic separation devices. The source exhibits certain advantages in comparison with gas discharge sources. Due to the absence of gas discharge, interference with ion beam oscillation processes is eliminated and the ion spectrum does not contain multicharged ions. Operational data on the source and results of K and Rb isotope separation are included. (tr-auth)

29597 EXCHANGE BETWEEN HYDROGEN AND DEUTERIUM. Victor Bayerl. *Canadian Patent* 619,681. May 9, 1961.

A moving-bed process for obtaining D_2 from H_2 gas and H_2O is outlined which employs carrier particles charged with a catalyst and an amount of liquid H_2O between 5 and 40%. The charged carrier is circulated countercurrently with H_2 gas in a hot-cold system. (D.L.C.)

29598 PROCESS AND APPARATUS FOR SEPARATION OF GASEOUS SUBSTANCES. Erwin W. A. Becker. *Canadian Patent* 624,264. July 25, 1961.

A process for separating gaseous isotopes is described in which the mixture is caused to issue from a nozzle in the form of an expanding supersonic jet and separated into its components by an apertured diaphragm. The heavy component is generally concentrated in the core portion. Unit apparatus and multi-unit configurations for carrying out the process are described. (D.L.C.)

29599 POROUS METALLIC MEMBRANES AND METHODS OF MANUFACTURING THEM. Gilberte Moutaud (to Commissariat à l'Energie Atomique). *Canadian Patent* 626,400. Aug. 29, 1961.

A method is outlined for making porous metallic membranes for use as diffusion barriers, e.g., in isotope separation. The method comprises mixing a fine powder of a metal or metal oxide with a suspension of plastifying material, flocculating the suspension mixture, laminating the mixture to form sheets, and sintering at high temperatures to remove the plastifying material. Where a metal oxide is used, it may be reduced to the metal by conducting the sintering process in a reducing atmosphere. The plastifying material should be a fluorohydrocarbon or chlorofluorohydrocarbon polymer, preferably Teflon. (D.L.C.)

MATHEMATICS AND COMPUTERS

Refer also to abstract 29323

29600 (APEX-601) PROGRAM ZIP, A GENERALIZED REACTOR (NUCLEAR ANALYSIS) SEQUENCE (IBM 7090). W. L. Orr (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). May 26, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 62p.

Program ZIP, an IBM 7090 computer program which carries out a generalized reactor design sequence, is described. Given the dimensions and material composition of each region that make up the reactor and shield assembly, the program determines in one pass through the computer a reactivity consistent in two separable spatial coordinates and the corresponding normalized flux and reaction rate distributions. A sample problem and the program listing for the seven major subroutines are included. (auth)

29601 (APEX-605) SHIELD REGION DATA CONVERTER PROGRAM 20-7. J. M. Martin (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Apr. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 49p.

Program 20-7, GE-ANPD Program 486, is a digital computer program which prepares input data for "Specialized Reactor-Shield Monte Carlo Program 18-0." Program 18-0 requires extensive and somewhat redundant information about the shield configuration in order to operate efficiently. This same information can be conveyed in a shorter, more concise form, but numerous adjustments and calculations must be performed to put the information into a form acceptable to Program 18-0. This is the purpose of Program 20-7, the output of which is a binary deck of cards to be inserted in the 18-0 binary deck. Further output contains printed listings of the volumes of the regions comprising the shield and comparisons of the coordinates included in the input with the adjusted coordinates used in setting up the data. The program searches for errors in the input, and should any be found, no output will be produced except printed comments about the types of error encountered. The program is written for an IBM 7090 Electronic Data Processing Machine with a memory capacity of 32,768 storage locations. One tape or on-line punch is required. (auth)

29602 (APEX-607) CONVERSION OF PROGRAM SHAG TO THE IBM-7090 (ANP PROGRAM NO. 518). F. D. Wenstrup (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Apr. 28, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 76p.

In converting Program SHAG to the IBM-7090 digital computer, several modifications were made to the earlier IBM-704 version. These changes include the reassignment of core storage for program variables, a more flexible decimal-input format, and program optimization in general. The changes which affect the successful running of the code are described. (auth)

29603 (APEX-643) COMPARATIVE STUDY OF FREE AND VAST VIBRATION ANALYSIS AND COMPUTER PROGRAMS. John Wallach (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). June 29, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 43p.

A comparative study is presented of the use of the FREE-FORCED and VAST vibration analysis computer programs. Based on a study of the programs, including the results of a few simple cases, a comparison is made as to their areas

of application, method of application and the types of answers obtained. Some of the items considered were number of degrees of freedom, stationary or rotating parts, number of critical frequencies desired, type of forcing, type of damping, and on or off-resonance response. (auth)

29604 (APEX-658) JOIN COMPUTER PROGRAM. John Wallach (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Apr. 28, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 19p.

JOIN is an IBM 7090 Computer Program that will calculate the spring constant matrix for a composite beam made up of not more than ten sections. It will also calculate the resulting spring constant matrix when one of three boundary conditions (pinned, built-in or double spring) is applied to the composite beam. The input consists of the beam section spring constant matrices and type of boundary condition and output is the composite spring constant matrix. The program is limited to beams with motion in one plane. The program was written to combine the results of the "General Beam" program (ANP No. 530) and "Cone Beam Equation" program (ANP No. 526) for use in the "Free" vibration program (ANP No. 332). (auth)

29605 (APEX-665) STATUS REPORT: ANP PROGRAM NO. 700, FANTASIA. J. A. Delaney (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Apr. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 41p.

Work performed on ANP Program #700, "FANTASIA," a generalized fluid thermodynamic program, is reported. Included are detailed specifications and a status report of coded subroutines. (D.L.C.)

29606 (BLG-65) MODIC, A ONE-DIMENSIONAL MULTIGROUP PROGRAMME. R. De Meersman (Brussels. Centre d'Etude de l'Energie Nucleaire). Jan. 31, 1961. 29p.

MODIC is a one-dimensional multigroup program for reactors written for a MERCURY computer. Fluxes in at most 32 energy groups can be calculated, using the Selengut-Goertzel approximation. Macroscopic cross sections can be derived from microscopic cross sections stored in the machine in library form. Inelastic scattering from any group to all groups with lower energy may be considered in the calculations. A δ^2 Aitken extrapolation process may be used to accelerate the convergence of the source term. The program can also perform few group calculations. In this case however, the number of groups should be 2 at least. (auth)

29607 (BNL-647) AN IBM 704 MONTE CARLO CODE TO CALCULATE FAST FISSION EFFECTS IN HOMOGENEOUS AND HETEROGENEOUS SYSTEMS. H. Rief (Brookhaven National Lab., Upton, N. Y.). Jan. 1, 1961. 22p.

A computer code is presented for calculating fast fission ratios and factors, and numerous geometry routines are given. The code computes the fast fission factors for the entire system, neutrons scattered only in the region of birth, and neutrons not scattered in the moderator; the ratio of secondary to primary neutrons for each isotope; fractional and over-all absorption; collisions; neutron escape probability; and the fast fission ratio. (D.L.C.)

29608 (CF-61-8-92) LT-1, A GENERAL REACTOR LIFETIME PROGRAM FOR THE IBM-7090. C. A. Preskitt

and R. S. Carlsmith (Oak Ridge National Lab., Tenn.). Aug. 29, 1961. 19p.

The LT-1 code calculates isotopic concentrations, absorption and fission rates, effective multiplication, and flux ratio as a function of time for an infinite heterogeneous or homogeneous medium. A leakage correction is applied. Both equilibrium and batch loaded cycles are covered, and both thorium and U^{238} systems. Absorptions in control material are assumed at each point in time so that the flux ratios are always characteristic of the just-critical system. (auth)

29609 (CNI-80) DESCRIZIONE DI UN PROGRAMMA COMPILATORE PER IL CALCOLATORE REMINGTON USS 90. (Description of a Program Compiler for the USS 90 Remington Computer). V. Macchi (Italy. Comitato Nazionale per l'Energia Nucleare. Centro di Studi Nucleari, Ispra). Dec. 1960. 20p.

The syntax and semantics of a compiler for USS 90 Remington computer are exposed. Programs are assembled in the interpretative F.I.A.T. system. The language of the compiler was successively extended to include arrays of numbers such as vectors and matrices. (auth)

29610 (GA-2460) EXTENDED TABLES FOR THE COMPUTATION OF THE VOLUME TERM OF THE RESONANCE INTEGRAL. V. W. Nather and L. W. Nordheim (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Aug. 30, 1961. Contract AT(04-3)-167. 7p.

An extension was made of the tables for the computation of the volume term of the resonance integral using the procedure by Adler, Hinman, and Nordheim. The values for $\xi = 0.0(0.005) 0.02$ and $\xi = 0.5 (0.1) 1.0$, and $k = 20.0 (1.0) 31.0$. (M.C.G.)

29611 (NP-10703) SOME PROBLEMS IN EXTENDING AND LIFTING CONTINUOUS LINEAR TRANSFORMATIONS. Leopoldo Nachbin (Rio de Janeiro. Centro Brasileiro de Pesquisas Fisicas). 1961. 21p. (Notas de Fisica, Vol. VII, No. 8).

A characterization is given of the classical Hahn-Banach theorem for problems in extending and lifting continuous linear transformations in Banach vector spaces E, F, and S. (B.O.G.)

29612 (ORO-TP-36) A DIGITAL COMPUTER PROGRAM FOR NUCLEAR RADIATION ASSESSMENT. Edwin M. Fulcher, Eugene C. McDowell, and Thomas R. Shaw (Johns Hopkins Univ., Bethesda, Md. Operations Research Office). 1961. 28p.

A program for the 1103A Univac Scientific Computer was developed to calculate accumulated nuclear-radiation doses received by mobile units in a nuclear battle. The program was designed to evaluate, either separately or all together, initial gamma and neutron radiation, residual radiation induced in the ground by air bursts, and fall-out radiation from ground bursts. Both the nuclear weapon ground zeros and the mobile units are referenced in time and space coordinates. For the purposes of fall-out evaluation the wind may have any speed and direction. The program provides for radioactive decay and attenuation due to air. Appropriate shielding is provided where applicable. (auth)

29613 (TID-13664) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. CIRCUIT RESEARCH PROGRAM. PART III. MATHEMATICAL METHODS. PART IV. DATA REDUCTION METHODS. PART V. ILLIAC USE AND OPERATION. PART VI. IBM 650 USE AND OPERATION. PART VII. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital

Computer Lab.). Apr. 1961. Contract AT(11-1)-415. 55p.

Progress is reported on the high-speed computer program, circuit research, mathematical methods, data reduction methods, Illiac use and operation, IBM 650 use and operation, and general laboratory procedures. (M.C.G.)

29614 (WAPD-TM-278) DART-A DIGITAL-ANALOG SYSTEM FOR COMPUTING REACTOR START-UP TRANSIENTS. W. G. Clarke (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Aug. 1961. Contract AT(11-1)-GEN-14. 78p.

A description is given of a digital-to-analog program which facilitates analog studies of reactor start-up transients. A FORTRAN-ALTAC program, written for use on the Philco 2000 digital computer, is used in conjunction with an Electronic Associates, Inc., 231R analog computer. The complete system provides an automatic solution for power range start-up transients on a reactor plant analog simulator. (auth)

29615 GENERATING RANDOM NOISE WITH RADIO-ACTIVE SOURCES. John B. Manelis (Univ. of Arizona, Tucson). Electronics, 34: No. 36, 66-9 (Sept. 8, 1961).

A random telegraph wave with a mean count of 80 kc and Gaussian noise with a power spectrum flat between d-c and 20 kc are provided. Fast analog computation and repetitive computer applications are made possible. (L.N.N.)

29616 THE AFFINE FIELD EQUATIONS IN A WELL BASED L_n . Dominic G. B. Edelen (RAND Corp., Santa Monica, Calif.). J. Math. Anal. and Appls., 2: 394-404 (1961).

Potential solutions of the affine field equations are presented for those cases in which the Lagrangian functions are pseudo-scalar densities of weight and class. These solutions are obtained from the study of affine connections in a well based L_n . The requirement of a symmetric affine connection is relaxed since the analysis is generalized and holds regardless of the affine field equations. (L.N.N.)

29617 AN INVESTIGATION OF THE APPLICABILITY OF THE PADÉ APPROXIMANT METHOD. George A. Baker, Jr., J. L. Gammel, and John G. Wills (Los Alamos Scientific Lab., N. Mex.). J. Math. Anal. and Appls., 2: 405-18 (June 1961).

By means of analysis and numerical examples, the range of applicability of the Padé approximant method is investigated. It is concluded that at least a subsequence of the $[N,N]$ Padé approximants for $f(z)$ converge uniformly to $f(z)$ in any closed, connected set on the Riemann sphere containing the origin but not containing any of the singular points or points on suitable cuts of $f(z)$. There are, however, certain types of singular points at which convergence does occur. (auth)

29618 DISCRETE BESSEL FUNCTIONS. R. H. Boyer (Westinghouse Research Labs., Pittsburgh). J. Math. Anal. and Appls., 2: 509-24 (June 1961).

The Laplace equation in cylindrical coordinates, $(\partial/\partial r)r(\partial\Phi/\partial r)(r,z) + r(\partial^2\Phi/\partial z^2)(r,z) = 0$, for a situation having axial symmetry is replaced by a partial difference equation. The "discrete Bessel functions," of which the definition and properties are presented, are used to construct solutions to this equation. (L.N.N.)

29619 ON RELATIVELY NONATOMIC MEASURES. J. R. Blum (Sandia Corp., Albuquerque, N. Mex.). Proc. Am. Math. Soc., 12: 457-9 (June 1961). (SCR-272)

Definitions of relative nonatomicity are given along with the proofs of the analogue of the convexity theorems for

the following case: Let Ω be a set, \mathcal{A} a σ -algebra of subsets of Ω , and m a measure defined on \mathcal{A} whose range R is a subset of k -dimensional Euclidean space. Now let \mathcal{A} be the class of Borel subsets of the real line, let $m = (m_1, m_2)$ where m_1 is Lebesgue measure and $m_2(A)$ counts the number of integers in the set A . Then R is not convex, in fact R is the set of points $\{(x, y)\}$ where x is equal or greater than zero and y is a nonnegative integer. Yet if $(x, y) \in R$ and (x, y) lie on the line segment connecting the zero vector and $m(A)$, it is easily seen that there exists $A' \subset A$ such that $m(A') = (x, y)$. The theorem to be proved is: let m be nonatomic relative to R . Let A be a set and $r \in R(A)$. Then there exists $B \subset A$ with $r = m(B)$. (N.W.R.)

29620 METHOD OF STATISTICAL-PROBABILISTIC SIMULATION IN APPLICATION TO THE CALCULATIONS OF FEYNMAN TYPE FUNCTIONAL INTEGRALS MEASURES OF WIENER AND FRESNEL. V. V. Chavchanidze and R. S. Shaduri. Trudy Inst. Fiz. Akad. Nauk Gruz. S.S.R., 7: 105-11(1960). (In Russian)

With the method of statistical-probabilistic simulation,

Feynman functional integrals may be calculated. It is shown that the information obtained from a functional integral of Feynman type is equivalent to the information obtained from two functional integrals of Fresnel type. Thus the Monte Carlo method is used for calculating the mean physical quantities determined by Feynman functional integral measures. (auth)

29621 STOCHASTIC PROCESSES. PROBLEMS AND SOLUTIONS. L. Takács. Translated by P. Zádor. Methuen's Monographs on Applied Probability and Statistics. London, Methuen & Co. Ltd. and New York, John Wiley & Sons Inc., 1960.

The theory, problems, and solutions of Markov chains and processes, and stationary, recurrent, and secondary stochastic processes are given. Proofs of the theorems are generally omitted or only a brief outline is given. The problems are taken from the field of natural sciences, engineering, and industry. Their solutions contain several mathematical models which can be applied in investigating empirical processes. (N.W.R.)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

29622 (DMIC-155) OXIDATION OF TUNGSTEN. V. D. Barth and G. W. P. Rengstorff (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). July 17, 1961. Contract AF33(616)-7747. 174p.

A detailed review is presented of available information on the oxidation of tungsten. Theories of oxidation mechanism, the effects of pressure, water vapor, and temperature on the formation and stability of tungsten oxides, and the reaction of tungsten at elevated temperatures with materials other than oxygen are covered. (auth)

29623 (DMIC-157) A SUMMARY OF THE THEORY OF FRACTURE IN METALS. J. W. Spretnak (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Aug. 7, 1961. Contract AF33(616)-7747. 63p.

The theoretical reasons for the discrepancies between the theoretical and observed strengths of metals are discussed. The theory of metal fracture, as it exists today, is reviewed. (auth)

29624 (DMIC-Memo-76) PRODUCTION AND AVAILABILITY OF SOME HIGH-PURITY METALS. E. M. Sherwood and V. S. Secrest (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Dec. 2, 1960. 61p. (PB-161226).

A review is presented of production techniques and the availability of high-purity beryllium, boron, chromium, niobium, iron, molybdenum, nickel, rhenium, tantalum, titanium, tungsten, vanadium, and zirconium. (B.O.G.)

29625 (HW-67677) THE PHYSICAL INTEGRITY AND CORROSION RESISTANCE OF THE ZIRCALOY-2 PRESSURE TUBES FOR THE PRTR. R. L. Knecht (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1960. Contract AT(45-1)-1350. 41p.

The physical integrity of the tubes was determined by ultrasonic, fluorescent penetrant, and radiographic techniques. By ultrasonic testing, the large and the small diameter portions of all reactor tubes were revealed clear of discontinuities that would produce an ultrasound reflection as great as a 3-mil longitudinal notch on the inner surface of a standard. By radiographic examination, the tapers were shown to be sound. By fluorescent penetrant testing, the majority of the tubes were shown free of discontinuities on both the inner and outer surfaces. Where there were penetrant indications, (application of the test was under development at the time), no discontinuities were found by ultrasonic or radiographic inspection. The inner and outer surfaces of the tubes have good corrosion resistance, as evidenced by the glossy black oxide film formed during autoclaving. Acid staining, which could mask the gray or white corrosion product of poor quality metal, was present on some of the tubes. A vapor blast procedure was developed that removed the oxide along with less than 0.001 inch of wall thickness. Stained tubes were successfully repickled and autoclaved. The minimum wall thickness of each tube was determined by ultrasonics. (auth)

29626 (LAR-54) INVESTIGATION OF HYDRIDING CHARACTERISTICS OF INTERMETALLIC COMPOUNDS. Third Quarterly Report, April 1, 1961-July 31, 1961.

Richard L. Beck (Denver. Univ. Denver Research Inst.). Aug. 1961. Contract AT(33-3)-3. 41p.

The hydriding characteristics of 161 different intermetallic phases are investigated. Of these, 51 are shown to react directly with hydrogen gas (15 of these form ternary hydride compounds). On the basis of these reactions, indirect evidence for the reaction of an additional 31 compounds is obtained. Pressure-temperature-composition relations are presented for the hydrides of 7 different intermetallic compounds. A partial analysis of these data indicates that a quantitative relation could be developed to predict whether or not a given compound has the potential ability of forming a hydride. This relation would be based on the size of available interstitial sites, metallic valence, coordination of metal-metal and metal-hydrogen atoms, and elastic lattice strain. Evidence is presented that indicates that the greatest thermal stability is exhibited by those hydrogen atoms that are bonded in the smallest sites. Also, the maximum hydrogen absorption in a ternary hydride is not limited to that attainable by the individual components of the compound. (auth)

29627 (MCW-1467) ALPHA PHASE VACUUM OUTGASSING OF DINGOT URANIUM. J. A. Fellows (Malinkrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). Aug. 21, 1961. Contract W-14-108-Eng-8. 117p.

A detailed description is given of the theory and practice that was developed for the control of hydrogen in dingot uranium metal by vacuum outgassing of fuel core blanks at an intermediate alpha phase temperature. Vacuum extraction procedures for hydrogen analysis are reported, with evidence of maximum precision in the use of Toepler pumps and a palladium membrane. Determinations of hydrogen diffusion rates have shown that the diffusion coefficient for the gamma phase is uninfluenced by carbon and hydrogen contents, that in the beta and alpha phases the true diffusivity can be measured only at low carbon and hydrogen levels. Apparent diffusion coefficients, materially lower than true diffusivities, are observed in outgassing high-hydrogen dingot metal or high-carbon ingot uranium. The dependence of apparent diffusivity on outgassing temperature and initial hydrogen content of dingot metal is expressed mathematically for use in calculating plant outgassing furnace cycles. The estimation of necessary time at the outgassing temperature is illustrated for a number of conditions of core blank geometry and degree of desired hydrogen removal. A maximum permissible outgassing temperature of 950°F is defined by evidence of metallographic grain coarsening in core blanks beta treated after vacuum outgassing at higher alpha phase temperatures. Studies of outgassing after beta treatment are also presented, giving the temperature ranges to be used, depending on whether recrystallization by annealing is to be sought or avoided. The experience in plant outgassing operations is quoted with the aid of histograms. Effective outgassing is shown to be favored when an accurate knowledge of apparent diffusivity is available and when the cross section of the core blanks is small, as in hollow shapes. (auth)

29628 (NP-10640) BERYLLIUM, A SURVEY OF THE LITERATURE. Jack B. Goldmann, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). June 1961. 102p. (SB-63-35)

References (215) are given to books, reports, and U. S.

and foreign journals published from 1958 to the first quarter of 1961. An author index is also included. (P.C.H.)

29629 (NP-10696) PREPARATION AND EVALUATION OF HIGH PURITY BERYLLIUM. Bi-Monthly Progress Report, May 2 to July 1, 1961. G. E. Spangler, Edward J. Arndt, and M. Herman (Franklin Inst. Labs. for Research and Development, Philadelphia). Contract NOW 61-0221-d. 14p. (P-A2476-4).

The final assembly of the apparatus for zone melting one-inch diameter beryllium rods was completed. In the initial trial of this apparatus, a stable zone was established and traversed in a cast bar. Four zone passes were made on this bar, resulting, after the fourth pass, in a single crystal one inch in diameter and four and one-half inches long. The melting of this bar resulted in a demonstration of several additional methods of purification accompanying vertical zone melting. A comparison of the ductility in the polycrystalline beryllium with about 6% ductility in tension, the same material converted to a single crystal by one zone melting pass, and the multiply zone-refined single crystals which used the polycrystalline beryllium as starting material and exhibited up to 130% over-all elongation was attempted. It was discovered that one zone pass is effective in removing precipitates which appear to limit ductility and thus the one-pass single crystal cannot be compared to the polycrystalline material from which it was formed. The deformation sequence to failure was not identical to the multiply zone-refined crystal showing the greatest ductility and therefore the one-pass ductility result could not be compared to it. Stress-strain curves were plotted to determine the relative impurity effect on the deformation sequence in beryllium. (M.C.G.)

29630 (PAN-204/IV) POLUCHENIE LITOGO METALLICHESKOGO URANA IZ OKISLOV URANA PUTEM ELEKTROLIZA RASPLAVLENNYKH SRED. (Production of Metal Uranium Ingot from Uranium Oxides by Electrolysis of Molten Media). V. Rafalski and E. Taubman (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). 1960. 7p.

Production of uranium metal ingots from uranium oxides by electrolysis of molten media is described. The cathode area is separated by an Al_2O_3 diaphragm, preventing the insoluble uranium oxides from mixing with precipitated uranium. (tr-auth)

29631 (TID-7614(p.93-116)) METHODS FOR PREPARING URANIUM CARBIDE IN BULK AND POWDER FORM. Herbert S. Kalish (Olin Mathieson Chemical Corp., New Haven).

A summary of activities in the area of methods development for UC preparation in powder and bulk form is presented. Particular attention is focused on methods being developed at Olin Mathieson. It is noted that apparently the preparation methods which offer most promise include the UO_2 -graphite route for arc melting stock and the alkane reaction for a powder product. (J.R.D.)

29632 (NP-tr-731) METALLO-CERAMIC METHOD OF OBTAINED ALLOYED MOLDINGS ON THE BASIS OF MOLYBDENUM. A. V. Savin. Translated from *Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo*, No. 6, 47-50(1960). 7p.

A study was made of the technology of preparing molybdenum alloys with titanium and zirconium by the metallo-ceramic method with a minimum amount of gases, and a strict limiting of the carbon content. Carbon in quantities above 0.05% was found to act as a deoxidizer in the presence of open porosity in the moldings heated to 2100°C in

a vacuum of 1×10^{-5} mm Hg. Introduction of more than 0.1 to 0.2% carbon does not lower the amount of oxygen, but leads to the formation of the second phase in the form of filaments between the grains of the solid solution. The degree of decarbonization of the molybdenum basically depends on the presence of moisture in the hydrogen atmosphere, and in the case of vacuum caking it depends on the oxygen content in the original powder. (B.O.G.)

29633 PURIFICATION OF THALLIUM BY CRYSTALLIZATION METHODS. T. I. Darvoid, V. N. Vigdorovich, and N. A. Iordanskaya (Kalinin Inst. of Nonferrous Metallurgy, Moscow). *Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo*, No. 3, 55-62(May-June 1961). (In Russian)

In connection with the current interest in Tl and its compounds for novel applications in atomic technology and instrumentation, there is an increased demand for a very high purity material; in particular the semiconductor-grade Tl must contain less than about $10^{-6}\%$ of each of Fe, In, Cd, Ca, Si, Cu, Sn, Hg, Pb, S and Zn. Therefore a systematic study was undertaken to remove the impurities by crystallization methods, making use of the currently available 29 partial phase diagrams of binary Tl systems. On the basis of the pertinent Tl-impurity diagram, the efficiency of the purification method could be estimated. Deviation from the anticipated behavior usually indicated secondary processes which in general enhanced the purification process; Cd, Hg and S could be removed by sublimation while oxidation reactions were found helpful to eliminate Sn and Cu. Stirring of zone melts in the recrystallization zone improved the purity of the end product. As Fe is insoluble in Tl, it must be eliminated by filtration. There are no very good methods available for removing Pb. Alkaline and electrochemical refining techniques show good promise. (TTT)

29634 A METHOD OF PRODUCING VERY DENSE ZrO_2 . Karl A. Sense (Atomics International, Canoga Park, Calif.). *J. Am. Ceram. Soc.*, 44: 465(Sept. 1961).

A two-step procedure was used to obtain zirconia with 2.05 mole % HfO_2 , with a density of 5.77 g/cm^3 . The two-step process consisted of hot-pressing very small particle-size zirconia powder below the monoclinic-tetragonal phase transformation and then sintering above 2250°C. The small-particle-size zirconia was produced by decomposition at 400°C under vacuum of purified zirconyl nitrate, $\text{ZrO}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$. The major impurity in the zirconia other than hafnium was 0.94 wt % sodium. Other impurities in ppm were aluminum 75, boron 2, calcium 1500, chromium 15, iron 300, magnesium 25, manganese 15, lead 15, silicon 75, and lithium 25. (N.W.R.)

29635 METALLURGY IN NUCLEAR POWER TECHNOLOGY. 5. FUEL ELEMENT CANNING MATERIALS. PART I. J. C. Wright (Coll. of Advanced Tech., Birmingham, Eng.). *Metal Treatment and Drop Forging*, 27: 449-54(Nov. 1960).

The extraction and fabrication of zirconium for fuel element cladding are described. A general discussion is presented of some of the other canning material used in reactors. (N.W.R.)

29636 LOW PRESSURE METALLURGY. THE REDUCTION OF OXIDES BY CARBON. A. S. Darling. *Metalurgia*, 64: 71-5(Aug. 1961).

(Continued from page 13 of the July issue).

The effects and processes for reducing the oxide content of chromium, copper, molybdenum, and niobium are discussed. Similarly, the effects and processes for reduc-

ing the carbon content of ferrochromium are discussed. It is shown that the oxides can be quantitatively reduced by carbon in vacuum. The process is limited to those metals, non-volatile at the reaction temperature, in which the tendency towards reduction is considerably greater than that leading towards carbide formation. The low carbon reduction process has the same requirements as for the oxide removal, except it applies in the opposite manner. (N.W.R.)

29637 ELECTROLYTIC PRODUCTION OF ZIRCONIUM METAL. Viorica Craiu, Paula Anghel, and A. Călusaru. *Rev. chim. (Bucharest)*, 11: 509-14(1960).

The method of electrolysis for the production of pure zirconium metal is presented. The experimental procedure is based on the electrolysis of potassium fluozirconate, dissolved in molten sodium chloride. The influence of the following parameters on the efficiency was studied: current density; temperature; composition of the electrolyte; electrolysis time; shape of the cathode; and nature of the cathode. The current density has a complex influence depending on the interval of the current density at which the work is performed, on the dimensions and the shape of the cell and on the dimensions of the cathode. A high current density proved to be advantageous. A temperature of 800°C represents a minimum value. By increasing it to 850°C, the deposition procedure is improved. Above this temperature, the variations are smaller. Thus, 850°C is the maximum. Practically, it proved to be advantageous to select a ratio of $K_2ZrF_6/NaCl$ equal to 1/2. The most advantageous electrolysis time was found to be 2-2.5 hr. Only cylindrical and truncated cone-shaped cathodes were tested, but they proved to be identical in their efficiency. With regard to the current efficiency, the nature of the cathodes has no influence on the procedure, but influences the purity of the product. Steel and graphite cathodes were excluded. Comparing a V2A cathode with a nickel cathode, the iron content of the zirconium produced was 0.5% higher for the V2A cathode. Electrolytic zirconium was analyzed spectrographically to establish the content of Cr, Cu, Mn, Sn, Al, Si, Fe, and Hf. Ni and Ca were not found. An iron content of about 0.1% was determined. The content of hafnium, being approximately 0.01%, does not modify the properties of zirconium. In an x-ray examination, no gaseous impurities were found. (OTS)

29638 ZONE PURIFICATION OF BERYLLIUM. W. R. Mitchell, J. A. Mullendore, and R. S. Maloof (Avco Corp., Wilmington, Mass.). *Trans. Met. Soc. AIME*, 221: 824-6 (Aug. 1961).

Preliminary experimental evidence is presented to show that the metallic impurities aluminum, iron, silicon, and beryllium oxide, as found in commercially pure hot-pressed beryllium powder, can be reduced to lower concentrations by zone-purification techniques. The reduction in the concentration of aluminum to extremely low levels (10 ppm) is noteworthy, since earlier work demonstrated that aluminum is a major factor contributing to the hot-tearing of beryllium during fusion welding. On the basis of present findings, a method is suggested for producing beryllium metal of improved weldability. (auth)

29639 MAGNETIC MATERIALS. Third Edition. F. Brailsford. London, Methuen & Co. Ltd. and New York, John Wiley & Sons Inc., 1960. 192p.

Materials which display magnetism to an extraordinary degree and which are said to be ferromagnetic are discussed. The discussions are centered on the theory, production, properties, factors affecting magnetic properties, and requirements of magnetic materials. (N.W.R.)

29640 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF SINTERED COMPACTS OF BERYLLIA. Peter Murray and David Thomas Livey (to United Kingdom Atomic Energy Authority). British Patent 876,640. Sept. 6, 1961.

A process is described for producing high-density sintered compacts from pure calcined beryllia powder. The process consists of cold-compacting a pure calcined beryllium oxide powder, heating the cold-compact to less than 1400°C for a period such as to cause substantially all the particles to be welded together, and then heating gradually or in stages to a sintering temperature of at least 1500°C. For example, the cold-compacted powder may be heated for 12 hours at temperatures between 1250 and 1400°C before sintering to 1500°C. (N.W.R.)

Corrosion

29641 (ARL-84) OXIDATION OF TANTALUM IN THE TEMPERATURE RANGE 500-700°C. Technical (Scientific) Note No. 4. Per Kofstad (Central Inst. for Industrial Research, Blindern, Norway). Apr. 1961. 58p. (SI Publ. No. 317).

The oxidation behavior of Ta was studied at 500 to 700°C and at O pressures ranging from 760 to 0.1 torr. Oxidation rate measurements and structural investigations of oxidized specimens by means of x-ray diffraction, electron diffraction, electron microscopy, and metallographic techniques were conducted. During initial stages, oxidation of Ta constitutes O dissolution in the metal and the formation of one or two suboxides, termed Ta_4O and TaO_2 , where TaO_2 probably is the end structure of an intermediate precipitation phase resulting from an ordering of dissolved O along dislocations and low-angle grain boundaries. During later stages a transition to a breakaway oxidation which eventually follows a linear rate is observed. The latter oxidation stage is accompanied by heavy Ta_2O_5 -formation. The linear oxidation is interpreted in terms of an O chemisorption equilibrium followed by a rate-determining reaction governed by nucleation and growth of Ta_2O_5 -nuclei. (auth)

29642 (BMI-1537) ELECTROPLATES ON THORIUM AND URANIUM FOR CORROSION PROTECTION AND TO AID JOINING. John G. Beach and Charles L. Faust (Battelle Memorial Inst., Columbus, Ohio). Aug. 14, 1961. Contract W-7405-eng-92. 38p.

Flat thorium panels withstood exposure to 200°F water-saturated air for over 600 hr, and to 120°F water-saturated air for over 2500 hr after nickel plating. The plating procedure involved removal of about 3 mils of surface metal by electropolishing, activation, plating of 2 to 3 mils of nickel in a leveling-type bath, and vacuum outgassing at 500°F. Essentially the same techniques were found satisfactory for uranium. Panels were protected for over 400 hr in water-saturated air at 200°F by 1 to 2 mils of electroplated nickel. Localized attack occurred at the bare plating contact areas. Chromium plating over the nickel coating prevented tarnishing. Application of a copper-plus-tin electroplate over the nickel coating made it possible to solder thorium and uranium successfully. The temperature of silver brazing, 1300°F, is too high for nickel-plated thorium and uranium, and bond failure occurs in the nickel-thorium and nickel-uranium alloy zones. (auth)

29643 (BMI-1539) DEVELOPMENT OF CONTAINER MATERIALS FOR THE FUSED CHLORIDE-ELECTROLYTIC FUEL-RECOVERY PROCESS. Paul D. Miller, Earl L. White, David C. Drennen, Carl H. Lund, Herbert J.

Wagner, A. M. Hall, and Walter K. Boyd (Battelle Memorial Inst., Columbus, Ohio). Aug. 28, 1961. Contract W-7405-eng-92. 42p.

Some 54 commercially available materials and alloys and 46 experimental alloys were investigated for their corrosion behavior in an environment simulating the HAPO molten-salt fuel-recovery system sparged with chlorine. At the same time, HAPO conducted a parallel investigation using the molten-salt system sparged with HCl. The chlorine-sparged system was much more corrosive. Both systems were operated at 800°C. A usable container material possessing a high order of corrosion resistance toward the fused-salt system, whether sparged with chlorine or with HCl, was not found. However, two alloys which showed promise of being acceptable were developed. One, nickel-13 wt.% aluminum-10 wt.% silicon, might be usable with the chlorine-sparged system for about 3 months. No data are available for exposure of this alloy to the milder HCl-sparged system. Tests of the other alloy, nickel-14 to 15 wt.% aluminum, indicated that it might serve considerably longer with the system sparged with HCl. (auth)

29644 (CF-61-2-95) HRT CORROSION SAMPLES—ADDITIONAL DATA ON SPECIMENS REMOVED PRIOR TO RUN NO. 20. J. E. Baker, M. D. Silverman, G. H. Jenks, and A. R. Olsen (Oak Ridge National Lab., Tenn.). Feb. 2, 1961. 36p.

Results of the examinations of corrosion specimens exposed in the HRT are presented. Specimens examined include core screen samples, core specimen array No. 1, blanket specimen array No. 2, core solution line specimen arrays No. 103 and 103A, and blanket solution line specimen array No. 203. These data include corrosion rates, computed from specimen weight-changes, and results of chemical analyses of scales removed from the specimens or specimen holders. A summary is included of the HRT operating schedule during exposure of the specimens and of the status of examinations for the specimens removed from the reactor prior to run 20. (auth)

29645 (CVNA-86) EVALUATION OF CONTROL ROD MATERIALS; CVTR PROJECT. Terminal Report. L. Marti-Balaguer and W. R. Smalley (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). [1960?]. For Carolinas-Virginia Nuclear Power Associates, Inc. Contract AT(30-1)-2289. 31p.

Mechanical and corrosion tests were performed on various control rod materials for CVTR application. The corrosion tests were carried out in demineralized static-water at 190°F and in a helium-water vapor atmosphere at 530°F. The mechanical tests were carried out at room temperature and at 250°F. The tests indicated that either boronated stainless steel or silver-indium-cadmium alloy would perform satisfactorily in the CVTR environment. Based primarily on the lower cost, boronated stainless steel was selected for the CVTR control rod. A prototype control rod was fabricated with boronated (1.5% B) stainless steel absorber material. The assembly was fabricated by riveting two absorber plates to AISI type 304 stainless steel center section. (auth)

29646 (MND-E-2014) ERDL-NPFO QUARTERLY PROGRESS REPORT [ON ANPP CORROSION] NUMBER SIXTEEN, APRIL THROUGH JUNE 1961. (Martin Co. Nuclear Div., Baltimore). July 1961. 28p.

The 2000-hr autoclave tests on Ni and Inconel were completed, and weight loss data are reported for Ni and Monel. The Ni coupons exposed to water containing 1000 ppm Cl and 15 ppm O suffered pitting corrosion. The operation of

the corrosion loop and the heat exchangers tested are discussed. Test results (heat transfer index and corrosion) are given for Inconel and bimetal heat exchangers; the Inconel vessels performed well with relatively little corrosion, while the bimetal vessels suffered extensive corrosion of the carbon steel secondary surface of the tubing. The status of model and miniature heat exchangers under test, fabrication, or design is tabulated. (D.L.C.)

29647 (NAA-SR-5926) MOLTEN PHOSPHATE REACTOR FUELS. II. CORROSION OF METALS IN MOLTEN SODIUM POLYPHOSPHATE. M. A. Hiller, T. L. Young, L. F. Grantham, and W. S. Ginell (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 15, 1961. Contract AT(11-1)-GEN-8. 37p.

Static, short-term corrosion screening tests of metals in molten sodium polyphosphate are carried out at 700°C. For a series of iron-nickel-chromium alloys, the initial corrosion rates are found to decrease with increasing nickel content of the alloy. The high molybdenum-content alloys (Hastelloys) and high chromium-content alloys (Inconels) exhibit relatively low corrosion rates. Among the pure metals, platinum, gold, vanadium, molybdenum, and tungsten are inert within limits of detection ($<0.02 \text{ mg cm}^{-2} \text{ hr}^{-1}$). Analyses of corrosion product films on metals indicate that metallic phosphides are formed. Pretreatment of metal samples with elemental phosphorus and subsequent corrosion testing of such samples result in a significant lowering of the observed corrosion rate, thus demonstrating the protective effect of self-healing phosphide films. A sodium sulfate-sodium polyphosphate melt (proposed low-viscosity reactor fuel matrix) reacts vigorously with iron-nickel alloys and molybdenum. Platinum again is unattacked ($<0.02 \text{ mg cm}^{-2} \text{ hr}^{-1}$). Observed corrosion products are elemental phosphorus and metallic phosphides. Those tests involving sulfate also show sulfur and sulfur dioxide as additional products. (auth)

29648 (ORNL-TM-2) THE EFFECT OF STRONG OXIDANTS ON CORROSION OF NICKEL ALLOYS BY FLUORIDE MELTS. F. F. Blankenship (Oak Ridge National Lab., Tenn.). Sept. 22, 1961. 3p.

When strong oxidants are present the nickel alloy shows a general attack, in addition to selective chromium removal. The removed metal redeposits dendritically, preferentially at a zone of lowest temperature, probably by a thermogalvanic mechanism. (auth)

Fabrication

29649 (AMC-TR-7-532a(II)) MACHINING OF REFRACTORY MATERIALS. Phase II Technical Engineering Report, January 24, 1961–April 30, 1961. L. J. Nowikowski, N. Zlatin, and M. Field (Metcut Research Associates Inc., Cincinnati). May 1961. Contract AF 33(600)-42349. 46p.

Machining studies were performed on René 41 solution treated to 321 BHN, René 41 aged to 365 BHN, and D6AC steel quenched and tempered to 56 Rc and 58 Rc. The investigation consisted of drilling tests on the René 41 alloy and turning, drilling and end milling tests on the D6AC steel. (auth)

29650 (AMC-TR-7-532a(III)) MACHINING OF REFRACTORY MATERIALS. Phase II Technical Engineering Report, May 1, 1961–July 31, 1961. L. J. Nowikowski, N. Zlatin, and M. Field (Metcut Research Associates Inc., Cincinnati). Aug. 1961. Contract AF 33(600)-42349.

Machining studies were performed on pressed and sintered unalloyed tungsten, René 41 solution treated to 321 H_N, René 41 aged to 365 BHN, and D6AC steel quenched and tempered to 56 R_c and 58 R_c. The investigation consisted of turning, face milling, and end milling tests on unalloyed tungsten; turning, face milling, end milling, drilling, reaming, and tapping tests on René 41; and turning, face milling, and drilling tests on D6AC steel. (auth)

29651 (APEX-649) TAPPED HOLES IN BERYLLIUM. J. D. Feith (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). July 10, 1961. Contracts AF33(600)-8062 and AT(11-1)-171. 21p.

Preliminary studies were carried out to determine the feasibility and the necessary design parameters for tapping threaded holes in beryllium. Data are given for the torque and tensile testing of the bolted beryllium samples. The results indicate that internal threads in beryllium are feasible. (D.L.C.)

29652 (APEX-699) FORMATION OF ALUMINA COATINGS ON BERYLLIA BY A VAPOR DEPOSITION PROCESS. R. R. Van Houten, J. F. White, and J. M. Botje (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). June 30, 1961. Contracts AF33(600)-38062 and AT(11-1)-71. 78p.

The theoretical and experimental work performed in developing a manufacturing process for cladding BeO and BeO base tubes with α -alumina (corundum) is described. The process employs the formation of alumina from the vapors of aluminum chloride according to the reaction $2\text{AlCl}_3 + 3\text{H}_2 + 3\text{CO}_2 \rightarrow \text{Al}_2\text{O}_3 + 3\text{CO} + 6\text{HCl}$. Suitable process gas compositions and process temperatures for depositing approximately 0.001 inch of dense α -alumina per hour were determined. It was further established that: The production of water vapor by reacting H_2 and CO_2 is the critical rate determining step in the process. Carbon monoxide depresses the rate of alumina deposition. High hydrogen concentrations promote the formation of water vapor by reduction of carbon dioxide. Depending on the process gas composition and operating variables different crystal forms of alumina can be obtained. The recommended operating procedure produces α -alumina having a density of 4.00 gms/cm³. The use of graphite or carbon components of the apparatus causes the formation of carbon monoxide which suppresses the rate of alumina deposition but this effect can be reduced by adding excess H_2 and coating the graphite parts with Al_2O_3 . A pilot run is described during which the bores of approximately 700 tubes were coated with α - Al_2O_3 to a thickness of 0.0006 inch. (auth)

29653 (APEX-737) INSULATION ATTACHMENT BY WELDING FOR AN AIRCRAFT NUCLEAR PROPULSION POWER PLANT. T. D. McLay (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Aug. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 24p.

The design, fabrication, and attachment of sheet metal insulation pads for protection of fibrous insulation in a high-velocity airstream are described. Three welding processes—resistance stud welding, arc stud welding, and tungsten inert gas welding—were evaluated for attachment of the pads to the structural wall. It is concluded that it is feasible and practical to insulate hot ducting on an aircraft nuclear power plant for service temperatures of 1600°F and service life of several hundred hours. The tungsten inert gas spot welding process was the most successful process. (auth)

29654 (ASD-TR-61-7-916) INVESTIGATION OF HYDROSTATIC EXTRUSION. Interim Technical Engineer-

ing Report No. 1, June 2, 1961–August 31, 1961. R. J. Fiorentino, A. M. Sabroff, and F. W. Boulger (Battelle Memorial Inst., Columbus, Ohio). Sept. 1961. Contract AF33(600)-43328. 7p.

Tooling is being designed for hydrostatic extrusion of SAE 4340 steel and Ti-6Al-4V titanium alloys into T-sections which can be inscribed in a 1-in. circle. The tooling is expected to be capable of withstanding extrusion pressures up to 250,000 psi at temperatures up to 500°F. Initial tests with this equipment will be made with materials such as lead and aluminum which can be extruded at lower pressures. (auth)

29655 (BMI-X-176) DEVELOPMENT OF COLD BONDING PROCESSES FOR THE CANDU REACTOR PROGRAM. Third Quarterly Report. S. W. Porembka (Battelle Memorial Inst., Columbus, Ohio). Sept. 12, 1961. 15p.

Cold bonding methods were investigated for joining pressure tubes of Zircaloy-2 and type 410 stainless steel for the CANDU reactor. Friction bonding, modified roll forming techniques, and explosive joining were studied. Fuel sheath end capping studies employing Zircaloy-2 materials are also described. (D.L.C.)

29656 (FRL-TR-8) ADHESIVE BONDING OF METALS FOR ADVANCED ORDNANCE APPLICATIONS. John J. Veliky, Raymond F. Wegman, Eileen R. Swick, and Michael J. Bodnar (Picatinny Arsenal. Feltman Research Labs., Dover, N. J.). Sept. 1960. 23p. (PB 161863)

An investigation was conducted to determine the practicability of bonding to various unusual metals such as beryllium, chromium, gold, silver, and U²³⁸. Two commonly used thermosetting adhesives, a polyester and a polysulfide-modified epoxy, were selected for evaluation on the basis of their ability to adhere to a variety of surfaces and their good cohesive strength characteristics. A modified epoxylated novolac was also evaluated for bonding some of the metals. Two additional adhesives, a polyurethane and an epoxy polyamide, were selected for use with the uranium because of difficulties encountered in bonding to this metal. Thermosetting adhesives of the styrene-unsaturated polyester and epoxy types gave reasonably good adhesion to stainless steel, titanium, beryllium, gold, silver, and chromium. Generally, an internally plasticized epoxy such as a polysulfide-modified epoxy gave better bond strengths at -65°F, whereas the more heat-resistant polyesters were better at 160°F. Polyamide-epoxy and polyurethane adhesives were used to obtain relatively good bonds to uranium. The bonds did not lose strength even after four weeks at 160°F or one year at temperatures ranging from 25° to 90°F. Tensile strength bonds of over 6000 psi were obtained to beryllium, gold, and chromium by using the filled, epoxylated novolac. Bond strengths attained to most of the metals with the polysulfide epoxy could be improved substantially by using a suitable filled epoxylated novolac adhesive. Because of its polysulfide modifier the epoxylated novolac did not give high strength bonds to silver. (auth)

29657 (GA-2105) DEVELOPMENT OF BRAZED AND CEMENTED JOINTS FOR THE HTGR FUEL-ELEMENT ASSEMBLIES. J. R. Lindgren (General Atomic Div., General Dynamics Corp., San Diego, Calif.). May 1, 1961. Contract AT(04-3)-314. 55p.

The development of techniques and equipment necessary for making low-permeability brazed and cemented joints in the graphite of the fuel-element assemblies for the High-temperature Gas-cooled Reactor (HTGR) is described. The investigation of brazing techniques has re-

sulted in a method for consistently producing brazed joints which exhibit permeability to gas as low as that of the graphite being joined. Cemented joints which exhibit gas permeability within a factor of one hundred of the permeability of the graphite being joined have been made with a reasonable degree of consistency. Thermal-cycling tests of brazed- and cemented-joint specimens are discussed. (auth)

29658 (HW-63266) TAPPING SMALL HOLES IN UNALLOYED PLUTONIUM. J. H. Rector and W. B. Weihermiller (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 1961. Contract AT(45-1)-1350. 30p.

Considerations affecting the tapping of small (8-32NC-2) holes in unalloyed Pu are studied. Best results are obtained using a straight two-flute ground thread tap; a maximum tap speed of 100 rpm; and a 2:1 mixture of perchloroethylene and lard oil as a lubricant. (T.F.H.)

29659 (LA-2563) ELEVATED TEMPERATURE IMPACT DENSIFICATION OF Mo- UO_2 POWDER MIXTURES. D. J. Murphy, R. S. Kirby, G. S. Hanks, and J. M. Taub (Los Alamos Scientific Lab., N. Mex.). July 11, 1961. Contract W-7405-ENG-36. 39p.

The effects of impact pressure applied at elevated temperatures in increasing the density of flat circular powder compacts of Mo + 20 vol.% UO_2 were investigated. The compacts were prepared by direct cold-pressing of powders and by blanking from powder-rolled strip. In some cases small additions of ThO_2 and TiO_2 were made to the compositions. Impacting pressures covered a range up to 61 tons/in.² at temperatures up to 1750°C. Densification behavior is discussed in terms of temperature and pressure of impacting, sintering, treatment, microstructure, and the effects of elevated temperature tests on the volatilization of UO_2 . In general, densities were observed to increase on the order of 15% by the methods used. (auth)

29660 (LA-2584) EVALUATION OF DRAWING LUBRICANTS FOR TANTALUM AND URANIUM. D. J. Murphy, R. I. Batista, G. S. Hanks, and J. M. Taub (Los Alamos Scientific Lab., N. Mex.). Apr. 5, 1961. Contract W-7405-eng-36. 23p.

A simplified testing device utilizing a draw bench and readily available auxiliary components was developed for evaluating the friction-reducing characteristics of possible lubricants for use with unusual metals and alloys for which such information is not yet available. Data were obtained for a variety of lubricants and die materials employed with tantalum and uranium, two such metals for which additional forming information is needed. The device and procedure provide a means for extensive evaluation of other combinations of dies, lubricants, and metals. (auth)

29661 (LAMS-2583) HOT PRESSING OF LOW-MOLYBDENUM-URANIUM ALLOYS. G. S. Hanks and L. S. Levinson (Los Alamos Scientific Lab., N. Mex.). July 7, 1961. Contract W-7405-Eng-36. 32p.

Normal uranium and uranium-molybdenum alloys containing 0.1, 1, and 2 wt % molybdenum were successfully formed by hot pressing in the gamma phase at 1000°C. Starting slugs of metal, 3 in. in diameter and 2 in. in height, were reduced over 50% in height. Graphite tools were used and no forming difficulties were encountered. The unit starting load for the 2% molybdenum alloy was 70% more than that for normal uranium, and the unit finishing load was 107% more than that for normal uranium. The finished hot-pressed slugs showed some refinement of grain structure and flow lines in the direction of deforma-

tion. The physical properties of the hot pressing were essentially the same as "as-cast" material. (auth)

29662 (NP-10659) THE MANUFACTURE OF Ti-7Al-12Zr SHEETS. Bi-Monthly Report No. 11, April 30, 1961 to June 30, 1961. J. K. Dietzel and S. R. Seagle (Reactive Metals, Inc., Niles, Ohio). Aug. 1961. Contract NOa(s) 59-6229-c. 14p.

During this reporting period, annealing temperature studies were concluded. The results of these studies showed that the best combination of creep strength and ductility could be obtained by annealing in the 1550 to 1600°F range. Production work during this period involved rolling the remaining intermediate gage sheet to final size. (auth)

29663 (NP-10660) COLUMBIUM POWDER METALLURGY PROJECT QUARTERLY PROGRESS REPORT NO. 1, PERIOD COVERED MAY 1 TO JULY 31, 1960. Thomas L. Robertshaw and John W. Pugh (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Contract AF33(616)-7254. 29p.

Preliminary studies of hot pressing parameters were completed and a balanced design begun, initial isostatic pressing and sintering studies were started and plans completed for plasma arc billet consolidation. Results indicate that in hot pressing F-48 prealloy powders: hydrided powder gives cleaner, more easily worked compacts than dehydrided powder; precompression of the powders is not necessary but convenient; a temperature sequence of high-low prior to pressing is undesirable because the powders bridge at the higher temperature; 100% density can be readily achieved at moderate temperatures and pressures; and the ability of small powder compacts to be rolled far surpasses its arc-cast counterpart. Preliminary tests of the homogenization and densification of cold presses and sintered F-48 made from elemental powders were encouraging. (N.W.R.)

29664 (NP-10661) COLUMBIUM POWDER METALLURGY PROJECT QUARTERLY PROGRESS REPORT NO. 2, PERIOD COVERED AUGUST 1 TO OCTOBER 31, 1960. Thomas L. Robertshaw, John W. Pugh, and Moses A. Levinstein (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Contract AF33(616)-7254. 28p.

Significant advances were made in the consolidation of F-48 by vacuum hot pressing and by cold pressing and sintering. The arc plasma deposition method has proven unenticing and will be dropped because of difficulties in maintaining purity and production levels. Workability of samples made from hot pressed or cold pressed parts is significantly better than arc cast material. One tensile specimen was made from hot pressed and rolled prealloyed powder. The strength and ductility compared favorably at 2200°F with values for sheet made from an arc cast ingot. Evaluation of hot pressed compacts of prealloyed powders show: particle size has a small but consistent effect on the density of a compact, finer particles yield denser billets; the denser billets are somewhat harder at room temperature and much more difficult to roll; and the conditions for consolidation for optimum rollability are close to the middle of the experimental design. Hot pressing conditions are 1.25 hr at 3400°F and 3500 psi. Cold pressing and sintering has not evolved any superiority of prealloyed powders over elemental powders in homogeneity, density, or forgeability. Particle size has no influence in this phase. Present procedure calls for isostatic pressing at 37000 psi and vacuum sintering in two steps to 4172°F. Pretreating powders by ball-milling and vacuum degassing at 3092°F have enhanced compactibility and handling of the green billets. (N.W.R.)

29665 (NP-10662) COLUMBIUM POWDER METAL-LURGY PROJECT QUARTERLY PROGRESS REPORT NO. 3, PERIOD COVERED NOVEMBER 1, 1960 TO JANUARY 31, 1961. Thomas L. Robertshaw and John W. Pugh (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Contract AF33(616)-7254. 59p.

Both hot pressing and isostatic pressing consolidation techniques are scaled up to 4 in. wide billets. Results from the balanced design experiment on hot pressed billets reveal the following conclusions: Higher oxygen content in the starting powder decreases rollability at any density. A critical density of 95% is necessary for good rollability. Microstructural changes occurring while hot-pressing to densities higher than 98% account for an inversion of rollability rating. Density is largely determined by hot-pressing temperature. Sintering kinetics, variation in properties with billet diameter, and homogeneity of elemental and prealloyed compacts are determined for the pressed and sintered billets. Rolling larger compacts verified the premise that the powder billets realize a higher material yield than arc cast billets. The powder sheet is produced with little or no in-process atmospheric protection costs. (N.W.R.)

29666 (NP-10663) COLUMBIUM POWDER METAL-LURGY PROJECT QUARTERLY PROGRESS REPORT NO. 4, PERIOD COVERED FEBRUARY 1, 1961 TO MAY 31, 1961. Thomas L. Robertshaw (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Contract AF33(616)-7254. 30p.

A study was made of the inert-arc-welding of F-48 sheet produced from hot pressed compacts. Despite scatter in bend test data, it was deduced that the welded sheet is as ductile as sheet from arc-cast material and can withstand almost three times as high a temperature as the arc-cast sheet before failure in the 6T radius bend test (longitudinal welds). In preliminary tensile, stress-rupture, and bend tests the powdered sheets are 85% as strong and quite as ductile as the arc cast product. Preliminary efforts to produce purer prealloyed powders through special hydriding and crushing were unsuccessful. The addition of 0.5% yttrium did not enhance the working, welding, or oxidation resistance of F-48 sheet. In processing compacts, large scrap losses are avoided by forging at 2200°F prior to rolling at 1400°F. Canning in titanium alloys will provide the necessary protection at 2200°F for the more porous sintered product. Final rolling temperatures are lowered to 750°F. A half-pound billet is rolled to 95% reduction with a 75% yield of material. (N.W.R.)

29667 (NUMEC-P-70) DEVELOPMENT OF PLUTONIUM BEARING FUEL MATERIALS. Progress Report for Period April 1 through June 30, 1961. (Nuclear Materials and Equipment Corp., Apollo, Penna.). 49p. Contract AT(30-1)-2389.

Activities are discussed for work done in the preparation of PuO₂ using the continuous oxalate process, and continuous coprecipitation studies using a uranium-20 wt % plutonium nitrate feed solution. Characterization studies of the PuO₂ powders indicated that variations in the processing variables can affect the final product. Measurements with the B. E. T. and Innes apparatus confirmed that the specific surface area of the initial batch of the PuO₂ powder had increased appreciably during storage. Deltatherm differential thermal analysis apparatus was checked out. Procedures were devised for the determination of plutonium and uranium. Sintering studies were continued for pure PuO₂, and sintering trials were begun for mechanically mixed and coprecipitated PuO₂ and UO₂. Metallographic examinations of

PuO₂ sintered pellets revealed a microstructural feature similar to eutectoid structures in alloys. Mechanical packing experiments were carried out using crushed UO₂ pellets fired to high density. Plasma torch production of UO₂ indicates that excellent spheroidization is attained, but central voids were found in the pellets. Reactor physics studies were completed for the analysis of the potential of plutonium as a fuel in near-thermal converter and straight burner reactors. Plutonium was shown to be promising fuel since Pu²⁴⁰ acts as a combination fuel and burnable poison. (B.O.G.)

29668 (NYO-9589) APPLICATIONS OF ULTRASONIC ENERGY, TASK 5: DEVELOPMENT OF ULTRASONIC ROLL-BOND CLADDING FOR PLATE-TYPE FUEL ELEMENTS. Quarterly Report No. 2, Covering Period From February 1, 1961 to May 1, 1961. (Aeroprojects, Inc., West Chester, Penna.). June 1961. Changed from OFFICIAL USE ONLY Aug. 1, 1961. Contract AT(30-1)-1836. 41p.

Theoretical investigations resulted in geometric improvements including a refined disk tip design and increased bending stiffness in the mechanical transformer, and other improvements in the 5-kw welding machine. Experimental investigations relating to further improvement in the transducer-coupling system including the disk tip have proceeded. The improved machine is about three times as efficient as the earlier machine used in this work; at an intermediate power level, it operates at nearly three times the speed and generates a bond band about 70% wider. The weld cladding of both simulant and 20 wt % U₃O₈ dispersion cores in the X8001 aluminum system has continued. Edge-clad dispersion specimens were prepared for evaluation, and a continuous multi-ply wrap-around technique was evolved. Face-clad specimens were made with consecutive multiple-layer seam-welding on the 2-kw welder in order to investigate the blister problem and its relationship to material properties and surface preparation. It appears that interfacial blisters formed by heating to 900°F after cladding may be virtually eliminated through adequate surface cleanliness, and evacuation of the space between cladding and core. No evidence of enfoldment blisters was observed when adequate power was used for high-speed weld cladding. (auth)

29669 (TID-7614(p.32-65)) ARC MELTING AND CASTING OF UC. M. H. Binstock (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Process development for UC fabrication at various U. S. sites is discussed, emphasizing arc melting and casting. (J.R.D.)

29670 (TID-13592) RECRYSTALLIZATION AND SINTERING OF OXIDES. Progress Report, September 1, 1960 to August 31, 1960. Ivan B. Cutler and Peter Gibbs (Utah. Univ., Salt Lake City. Inst. for the Study of Rate Processes). Aug. 31, 1961. Contract AT(11-1)-82. 67p.

Progress was made toward understanding the effect of impurities on the properties of alumina and magnesia previously proposed for investigation. Systematic investigation of variables thought to influence the rate of shrinkage of powder compacts was carried out. Geometry of powder particles as well as experimental factors associated with shrinkage measurements were investigated. The activation energy for diffusion for several different types of alumina powders was determined to be 135 Kcal/mole. Measurement of the electrical conductivity of sapphire showed it to be ohmic and history dependent below about 1300°C and non-ohmic above that temperature. Preliminary experiments indicated conductivity through the air

surrounding the sample is larger than through the sample itself at temperature above 1300°C. Exaggerated grain growth in sintered alumina is impurity dependent. At least one of perhaps several impurities that can influence exaggerated grain growth is sodium oxide, a common constituent of all commercial alumina powders. The chemical nature of sodium oxide and its volatility at high temperatures makes quantitative measurements extremely difficult; however, qualitative results amply demonstrate the effect of sodium oxide in stimulating exaggerated grain growth. Normal grain growth proceeds in sintered magnesia and calcia with little regard to changes in porosity. Self consistent data were obtained with reagent grade oxides; however, recent work gives evidence of a large dependence of grain growth on impurities. The diffusion of iron oxide (FeO) into magnesium oxide single crystals can be followed readily by observing movement of a colored interface. The rate of movement is dependent upon the vacancy concentration as determined by the $\text{Fe}^{+3}/\text{Fe}^{+2}$ ratio in the FeO. The diffusion profile also confirms the idea that the diffusion constant is concentration dependent. This result is to be expected on the basis that cation vacancies accompany the diffusion of trivalent iron ions into the magnesia lattice. (auth)

29671 ELECTRON BEAM WELDING THOSE HARD-TO-JOIN METALS. Mars Hablanian. *Assembly & Fastener Eng.*, 4: 36-40 (Jan. 1961).

Metals that must be welded in vacuum or an inert gas atmosphere, dissimilar reactive and refractory alloys, and extremely thin sections are discussed. Machine settings and results are tabled for welding Zircalloy, molybdenum, stainless steel, niobium, tantalum and niobium-vanadium alloy. (TCO)

29672 WELDING AT CHALK RIVER. J. V. Cornwell. *Can. Welder*, 51: 12-14; 16-18 (Jan. 1961).

Welding tests and specialized welding techniques used are described. Methods of remote control and induction pressure welding are discussed. Applications to stainless steel, aluminum alloys, and carbon steels are given. (TCO)

29673 WELDING IN ATOMIC POWER PLANTS. R. W. Nichols. *Ingeniøren*, 69: 592-8 (Oct. 15, 1960).

Arc welding Monel 60, 130, and 140, vanadium, niobium, and various alloy steels are described. The influence of relief annealing for 48 to 100 hr at 600°C and of neutron irradiation on transition temperature for the embrittlement of base and filler metal are also described. 6 ref. (TCO)

29674 HOT WORKING OF NIOBIUM ALLOYS. L. L. Gill and B. B. Argent (Univ. of Sheffield, Eng.). *J. Less-Common Metals*, 3: 305-11 (Aug. 1961). (In English)

The hot working characteristics of several two-phase niobium-carbon alloys were investigated, and the results are discussed in terms of solid solution hardening and dispersion hardening. (auth)

29675 METALLURGY IN NUCLEAR POWER TECHNOLOGY. 2. CASTING AND WORKING URANIUM AND THORIUM. J. C. Wright (College of Advanced Tech., Birmingham, England). *Metal Treatment and Drop Forging*, 27: 307-16 (Aug. 1960).

The casting and working of thorium and uranium are described from the point of view that they will be used in nuclear power production. (N.W.R.)

29676 EXTRUSION OF LITHIUM WIRES OF 1 Mil DIAMETER. J. Katzenstein and M. Sydor (Univ. of New Mexico, Albuquerque). *Rev. Sci. Instr.*, 32: 989 (Aug. 1961).

Fine wires of lithium and other alkali metals, which pose difficulties because of softness and chemical activity, were produced by extrusion. A simple die permitting extrusion of uniform wires down to one mil in diameter was developed. The extrusion was done in a carbon dioxide atmosphere. Wires of up to three feet in length were drawn, and the wire readily acquired an electrostatic charge. A sketch of the die is presented. (L.N.N.)

29677 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF SHAPED CARBON BODIES. Michael Stuart Thomas Price (to United Kingdom Atomic Energy Authority). *British Patent* 876,924. Sept. 6, 1961.

A method is described for producing a shaped carbon body of density at least 1.69 g/cc from which a graphite body may be produced with a density of at least 1.75 g/cc. The method for the carbon body consists of forming a shaped plastic mass of powdered carbon or graphite with a fusible cokable binder and baking at 800 to 1000°C to effect coking of the binder under a constant pressure of at least 100 psig, preferably 180 psig. The rate of heating to the maximum temperature is never greater than 6°C per hour. To obtain a graphite body from this process, the carbon shaped body is further baked to a graphitizing temperature, for example, 2000 to 3000°C. (N.W.R.)

29678 APPARATUS FOR WORKING MATERIALS BY MEANS OF A BEAM OF CHARGED PARTICLES. Wolfgang Opitz, Helmut Spruck, and Karl H. Steigerwald (to Carl Zeiss). *Canadian Patent* 626,554. Aug. 29, 1961.

A vacuum apparatus for working materials, e.g., drilling, milling, welding, etc., by means of a charged particle beam is designed with a stereomicroscope device for observing the working process. The optical axis of the microscope coincides with the axis of the incident beam, the beam being passed to the workpiece through a bore in the microscope or by deflection with a magnetic field. (D.L.C.)

Properties and Structure

29679 (AD-238334) RESEARCH ON THE BEHAVIOUR OF NIOBIUM AND NIOBIUM ALLOYS AT HIGH TEMPERATURES. Technical Status Report No. 7, October 1, 1959-December 31, 1959. Per Kofstad (Central Inst. for Industrial Research, Blindern, Norway). Jan. 20, 1960. Contract AF61(052)-90. 10p.

Discussions are included of activities in the preparation, analysis, oxidation, and structural studies of oxidized specimens of niobium and Nb²⁵ at.% Ti, and Nb⁵⁰ at.% Zr, and several ternary and quaternary niobium alloys. Graphical representations are given showing the weight gain as a function of time for some of the alloys in oxidizing atmospheres at 760 mm Hg and at 900 and 1200°C. (B.O.G.)

29680 (AERE/EMR/PR-1084/3) BINARY CARBIDE-METAL SYSTEMS. Progress Report No. 3. (Sheffield, England. Univ.). Agreement No. 13/5/165/1084. [nd.]. 5p.

Activities are reported in a program to examine the UC-Fe system from 100 wt.% UC to 100 wt.% Fe at 1100 to 1700°C. In other work, the UC-Cr system is being examined at compositions from 100% Cr to 100% UC at 1300 to 2000°C. (J.R.D.)

29681 (AGARDograph-51) AN INITIAL ASSESSMENT OF GRAPHITE AS A STRUCTURAL MATERIAL IN CONDITIONS OF HIGH THERMAL FLUX. A. J. Kennedy (North Atlantic Treaty Organization, Paris. Advisory Group for Aeronautical Research and Development). Sept. 1960. 39p.

The state of fundamental knowledge on graphite and the graphitization process is reviewed. The present state of development of four principal methods of manufacture is examined. The erosion of graphite, the use of coatings, the addition of vaporizing compounds and the development of new graphites are discussed. Considerations relating to thermal shock, creep, and fabrication are surveyed. Some of the conclusions are: that graphite is of singular importance to high-temperature technology, that commercial issues cannot be allowed to impede vigorous development toward more resistant forms, that much is to be gained by viewing graphite from a metals standpoint, that the fundamental theory of the basic crystal mechanics is undeveloped, that the present wide variability in properties should not be regarded overseriously, that non-destructive assessment by damping measurements needs development, that coatings and impregnants are of high priority, and that, of all factors, oxidation is the most serious limitation to use at the present time. (auth)

29682 (AGC-1777) MODULUS OF RUPTURE MEASUREMENTS ON BERYLLIUM OXIDE AT ELEVATED TEMPERATURES. Final Report, June 15, 1959–February 15, 1960. Melvin L. Stehsel, Robert M. Hale, and Cecil E. Waller (Aerojet-General Corp., Azusa, Calif.). Mar. 1960. Contract W-7405-Eng-48. 35p.

A bend-test furnace is described for measuring the modulus of rupture on beryllium oxide at elevated temperatures. Test beams were subjected to three-point loading by utilizing a conventional Instron tensile-testing machine. These tests were performed in a helium atmosphere at temperatures ranging from 75 to 3000°F. Comparative data are presented for hot-pressed, cold-pressed, and slip-cast specimens supplied by several manufacturers. Preliminary results indicated that, in general, the hot-pressed specimens have the highest modulus at all temperatures which were investigated. (auth)

29683 (ANL-6112) A NEUTRON DIFFRACTION STUDY OF KRYPTON IN THE LIQUID STATE. Glen T. Clayton and LeRoy Heaton (Argonne National Lab., Ill.). June 1961. Contract W-31-109-eng-38. 67p.

A study was made of the neutron diffraction patterns obtained from Kr liquid under seventeen conditions of temperature and pressure at 117 to 210°K. The low temperatures were used because the diffraction patterns and the corresponding radial distribution functions are more sharply defined near the liquid triple point. (J.R.D.)

29684 (ANL-6389) DESIGN CRITERIA FOR STEEL IN NUCLEAR REACTORS. S. H. Fistedis (Argonne National Lab., Ill.). July 1961. Contract W-31-109-eng-38. 19p.

Criteria for stress analysis and structural design with steel for the critical components of nuclear plants are presented. An effort was made to integrate the effects on the strength of steel of the coexisting phenomena, such as mechanical and thermal loads, stress cycling and fatigue, creep and creep rupture, irradiation, and loss of ductility. Extensive use of the plastic region of steel was made for the accommodation of thermal stresses. The concept of cumulative damage in the plastic region was expounded for thermal fatigue and creep. A short description is given of the five avenues followed for the development of a theory governing the strength of materials. An approach was taken up that attempts to establish a "theory of fatigue" based on experiments. (auth)

29685 (APEX-623) PHYSICAL AND MECHANICAL PROPERTIES AND OXIDATION-RESISTANT COATINGS

FOR A TUNGSTEN-BASE ALLOY. W. G. Baxter and F. H. Welch (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). July 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 89p.

The physical and mechanical properties of the commercially available 90 W-6 Ni-4 Cu alloy and its 0.2 (percent by weight) boron modification are presented. The effects of irradiation on tensile strength and dimensional stability also are included. The status of the oxidation-resistant-coating program for the alloy is summarized. Two promising coatings are introduced (the GE-81 braze alloy and the Coast Metals 50 Special alloy), and their performance is described. The latter coating, although not fully developed, shows promise for 300-hour operation at 1500°F under temperature-cycling conditions. (auth)

29686 (APEX-744) INVESTIGATION OF THE EFFECTIVE THERMAL CONDUCTIVITY OF CAST LITHIUM HYDRIDE. Lindley Manning and David J. McKee (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). June 5, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 38p.

The effective thermal conductivity of cast lithium hydride was evaluated as a function of temperature as influenced by non-homogeneous (cracked) distribution, various gases in cracks and voids, finned surfaces, and partial adhesion to the container. The over-all effective thermal conductivity of lithium hydride between the outer surface of its container and the surface of an enclosed cooling tube can be established at 6.1 and 3.0 Btu/hr-ft-°F at 250 and 900°F, respectively, by using finned surfaces on the O.D. of the tube and a helium internal atmosphere. The use of finned surfaces alone will raise the over-all effective thermal conductivity to 3.3 and 2.6 Btu/hr-ft-°F at 250 and 900°F, respectively. The conductivity can be increased further by introducing a gas into the cracks and voids in the lithium hydride. (auth)

29687 (ARF-2210-4) IMPROVED VANADIUM-BASE ALLOYS. Bimonthly Report No. 4, June 1, 1961–July 31, 1961. B. R. Rajala and F. C. Holtz (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Aug. 25, 1961. Contract NOW 61-0417-c. 14p.

Solid solution and dispersion-strengthened vanadium-base alloys were evaluated for use at temperatures in the 1200° to 2200°F range. The alloy V-1 wt % Hf-60 wt % Nb exhibited an ultimate tensile strength of 44,000 psi at 2200°F. Good strength at 2200°F was also observed for a V-1 wt % Ti-60 wt % Nb-5 wt % W composition. At 2000°F, the V-1 wt % Ti-60 wt % Nb-0.025 wt % C alloy withstood a stress of 10,000 psi for 25 hours. A portion of a 3-inch diameter extruded bar of V-5 wt % Ti-20 wt % Nb was rendered to excellent quality 0.050 inch thick sheet by hammer forging followed by warm and cold rolling. (auth)

29688 (ARF-2227-1) HIGH-TEMPERATURE OXIDATION PROTECTIVE COATINGS FOR VANADIUM-BASE ALLOYS. Bimonthly Report No. 1, June 12, 1961–August 11, 1961. F. C. Holtz (Illinois Inst. of Tech., Chicago, Armour Research Foundation). Sept. 8, 1961. Contract NOW-61-0806-c. 17p.

A wide range of coating techniques is being investigated for the oxidation protection of vanadium alloys at temperatures above 1800°F. Coatings of Zn, Zn-10 wt.% Al, Zn-10 wt.% Sn, and MgNi₂ were prepared to explore self-healing properties on V-5 wt.% Ti-20 wt.% Nb and V-60 wt.% Nb. Diffusion-type coatings included the pack-cementation of silicon on V-5 wt.% Ti-20 wt.% Nb. After exposure to air for 28 hours at 1800°F and 4 hours at 2000°F,

the coatings were intact, but small weight losses indicated the loss of V_2O_5 . Other approaches currently under study include roll-bonding of Fe-Cr-Al, the liquid-phase sintering of a Cr-Au alloy, and flame-sprayed barium titanate. (auth)

29689 (BM-RI-5850) ZIRCONIUM-GADOLINIUM EQUILIBRIUM DIAGRAM. M. I. Copeland, C. E. Armantrout, and H. Kato (Bureau of Mines, Albany Metallurgy Research Center, Ore.). June 1960. 16p.

The Zr-Gd phase diagram investigation was conducted to further the development of a less corrosive alloy containing the high thermal-neutron cross-section Gd. Results are illustrated. It is noted that alloys containing more than 5% Gd probably have reduced corrosion resistance. (J.R.D.)

29690 (BMI-1532) DEVELOPMENT OF DILUTE PLUTONIUM ALLOYS. Victor W. Storhok, Arthur A. Bauer, and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). July 27, 1961. Contract W-7405-eng-92. 26p.

Plutonium is being studied as a substitute fuel for uranium-235 in alloys for high-temperature use and for spike elements in power reactors. Alloys being studied include niobium-plutonium, niobium-plutonium-silicon, niobium-plutonium-zirconium, thorium-plutonium, and thorium-plutonium-zirconium. Binary alloys of niobium-plutonium show little promise as fuels since plutonium solubility in niobium was found to be negligible. Development of dispersion-type fuels consisting of a plutonium-silicon compound dispersed in a niobium matrix appears feasible on the basis of tentatively outlined phase regions in the niobium-plutonium-silicon system. Niobium-plutonium-zirconium alloys are found to consist of zirconium-plutonium alloy phases dispersed in a niobium-zirconium solid solution; the zirconium-plutonium phases appear amenable to spheroidization by heat treatment. Plutonium is found to strengthen thorium as indicated by room-temperature hardness measurements, although a 10 wt.% zirconium addition to a thorium-10 wt.% plutonium alloy produces a greater hardness increase than does 30 wt.% plutonium. The recrystallization temperature of thorium-plutonium alloys is apparently below 650°C, 80 and 90% cold-reduced alloys recrystallizing within 1 min at this and higher temperatures. The addition of zirconium apparently increases the recrystallization temperature to above 700°C. (auth)

29691 (BMI-1533) XENON DIFFUSION IN SINGLE-CRYSTAL AND SINTERED UO_2 . Russell H. Barnes, Mihkel Kangilaski, James B. Melehan, and Frank A. Rough (Battelle Memorial Inst., Columbus, Ohio). Aug. 1, 1961. Contract W-7405-eng-92. 42p.

The diffusion of xenon in single-crystal and in sintered UO_2 was studied by short-time neutron activation and subsequent heating. Considerable effort was devoted to the study of releasing area in the sintered material. It was found that diffusion rates in UO_2 single crystals at 1400°C are about two orders of magnitude lower than for sintered UO_2 materials. It is believed that this difference is associated with the presence of fewer defects in the single-crystal material, probably as a result of the lower metallic-impurity content and greater crystalline perfection. No grain-boundary effects were observed for specimens having 2.2- and 23.7- μ grain sizes. (auth)

29692 (BNL-648) ENGINEERING-SCALE PREPARATION AND CHARACTERISTICS OF ThO_2 -Bi SLURRIES. W. F. Kenney and H. Susskind (Brookhaven National Lab., Upton, N. Y.). Aug. 1960. 61p.

Dispersions of up to 11.5% ThO_2 in Bi (containing 350 ppm each of Mg and Zr) were prepared in 50-lb batches and studied as part of the Liquid Metal Fuel Reactor development program. Five different varieties of oxide were used, four produced commercially by calcination of the oxalate and the fifth prepared by calcination of the hydroxide. Their characteristics and the dispersion techniques are described. Uniform dispersions were obtained in all cases except with the ThO_2 prepared from hydroxide. Slurry uniformity appeared to be unaffected by long periods of settling or by variations in temperature. Agitation under He pressure, followed by a sudden decrease in pressure, resulted in the generation of froth. No significant reduction of the Th was observed. The Mg and Zr additives and Fe (from corrosion of the container wall) were found to be strongly associated with the ThO_2 particles in the slurry. All the dispersions possessed good fluidity up to the maximum concentration studied. The $2\frac{1}{4}$ Cr-1 Mo steel agitator impellers, which were operated with tip speeds of about 17.5 ft/sec, suffered slight erosion in some cases. Dispersions containing up to 7.4% ThO_2 were also successfully circulated in a $\frac{1}{2}$ -in.-IPS pumped loop, both isothermally and under a 30°C bulk temperature difference (515° to 485°C). At a velocity of 1.4 ft/sec, good stability was observed and no froth was encountered. (auth)

29693 (CAL-PI-1273-M-7) AN INVESTIGATION OF THE THEORETICAL AND PRACTICAL ASPECTS OF THE THERMAL EXPANSION OF CERAMIC MATERIALS. Quarterly Progress Report. Harold T. Smyth and Kenneth M. Merz (Cornell Aeronautical Lab., Inc., Buffalo). June 15, 1960. Contract NORD-18419. 5p. (AD-239649).

Summaries are presented of activities in the development of a method for computing the field at the location of each ion, and experimental measurements of the thermal expansion coefficients of MgO - $MgO \cdot Al_2O_3$ systems, and BeO - MgO systems. (B.O.G.)

29694 (DMIC-156) DESIGN INFORMATION ON AM-350 STAINLESS STEEL FOR AIRCRAFT AND MISSILES. R. J. Favor, O. L. Deel, and W. P. Achbach (Battelle Memorial Inst., Defense Metals Information Center, Columbus, Ohio). July 26, 1961. 46p.

Tentative room-temperature design-allowable strengths and elevated-temperature design curves are presented for short-time ultimate tensile strength, tensile yield strength, compressive yield strength, ultimate shear strength, bearing ultimate strength, and bearing yield strength. (auth)

29695 (DMIC-46I) STATISTICAL ANALYSIS OF TENSILE PROPERTIES OF HEAT-TREATED Ti-4Al-3Mo-1V SHEET. H. R. Ogden, G. H. Beatty, and A. E. Mace (Battelle Memorial Inst., Defense Metals Information Center, Columbus, Ohio). Sept. 16, 1960. Contract AF18(600)-1375. 32p. (PB-151095)

Data were analyzed statistically to determine the magnitude of the variation in the tensile properties and the relation between these properties and some of the processing variables. (auth)

29696 (DMIC-Memo-123) REVIEW OF RECENT DEVELOPMENTS IN THE TECHNOLOGY OF BERYLLIUM. Webster Hodge (Battelle Memorial Inst., Defense Metals Information Center, Columbus, Ohio). Aug. 18, 1961. 5p.

Reports and articles on the technology of beryllium received by DMIC during May, June, and July, 1961 are reviewed. It was found that a fast cooling rate is necessary for producing fine-grained, sound, cast beryllium ingots. An effect from impurities on the critical resolved shear stress for beryllium was shown to exist. Studies were

made of surface damage and mechanical properties of beryllium. The effects of water vapor on corrosion by carbon dioxide were determined. Analysis showed that the reaction products were BeO and Be₂C. (M.C.G.)

29697 (DMIC-Memo-124) INVESTIGATION OF DELAYED-CRACKING PHENOMENON IN HYDROGEN-ATED UNALLOYED TITANIUM. R. A. Wood, D. N. Williams, and H. R. Ogden (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Aug. 30, 1961. 20p.

An investigation of strain-aging embrittlement in unalloyed Ti was conducted. The effects of H on the delayed cracking of grades A, B, and C were also examined. No precise information was obtained on embrittlement and on failures which were reported, however it is believed that a stress-relief annealing treatment which would also redistribute the H concentrations offers a solution to the problem. (J.R.D.)

29698 (DMIC-Memo-126) A REVIEW OF RECENT DEVELOPMENTS IN TITANIUM AND TITANIUM ALLOY TECHNOLOGY. R. A. Wood (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Sept. 15, 1961. 8p.

Information on developments in titanium metallurgy that became available to the Defense Metals Information Center during the period from June through August, 1961 is reviewed. (M.C.G.)

29699 (GAMD-2298) AN INVESTIGATION OF SOME OF THE CAUSES FOR THE SPALLING OF IMPREGNATED GRAPHITE. W. L. Kosiba, G. R. Tully, Jr., and B. Turovlin (General Atomic Div., General Dynamics Corp., San Diego, Calif.). June 19, 1961. Contract AT(04-3)-314. 27p.

The impregnation process of the graphite used for investigations of spalling is described. Polished graphite specimens were examined at room temperature using bright field metallographic techniques. The gas evolution characteristics of impregnated graphite were also determined. Results indicated that the amount of impregnant introduced during the fourth impregnation cycle could be a critical factor in causing spalls in the manufacturing process. The permeability of the impregnated graphite was found to increase with the temperature to which the impregnated graphite was heated. Studies showed that the most significant changes in the impregnant and in the gas evolution occurred in the temperature range of 100 to 600°C. These results suggested that a slower heating rate during carbonization is likely to reduce spalling. A tentative mechanism for spalling is offered. (M.C.G.)

29700 (HW-66066) A NOTE ON THE ULTIMATE CONTRACTION OF GRAPHITE. D. R. de Halas (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 13, 1960. 4p.

A note on the possible phenomena that may occur during high temperature irradiation of graphite is presented. It is not contended that these processes occur, rather the emphasis is on the consequences of two apparently reasonable processes which are examined. (J.R.D.)

29701 (HW-67715) EVALUATION OF IRON- AND NICKEL-BASE ALLOYS FOR MEDIUM AND HIGH TEMPERATURE REACTOR APPLICATIONS. PART I. H. J. Pessl (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 1961. Contract AT(45-1)-1350. 69p.

The behavior of austenitic and ferritic stainless steels, iron-chromium-aluminum base alloys and nickel-base

superalloys, in medium and high temperature simulated reactor environments, was evaluated. Hastelloy alloys X, N, and F were the most resistant of the alloys tested to dry, purified CO₂ up to 1100°C (2012°F) and ambient pressure. AISI 316 SS, 347 SS and 446 SS were affected least by exposure to pure water at 360°C (680°F) and 3200 psi pressure. Some Fe-Cr-Al base alloys rated best in their combined oxidation and corrosion resistance; among these the AISI 406 SS, a commercial alloy commonly used as electrical resistance heating element material, was most promising as an economic fuel cladding and a reactor core component material, especially for gas-cooled reactors to maximum temperatures of 816°C (1500°F). (auth)

29702 (IA-616) URANIUM LAVES PHASE COMPOUNDS OF THE MgCu₂ TYPE. G. Katz and A. J. Jacobs (Israel. Atomic Energy Commission, Tel-Aviv). July 1961. 9p.

Laves phase studies were made for UAl₂, UMn₂, UFe₂, and UCo₂ intermetallic compounds which are of the MgCu₂-C₁₅ cubic type. Tabulations are given of the lattice constants, atomic diameters, and deviations of interatomic distances. A graphical representation is included of the ratio of the atomic diameters of the compounds as a function of the deviation of interatomic distances between the atoms in the compounds. A discussion is presented comparing the results with previous findings. (B.O.G.)

29703 (LAMS-2604) HINDERED SETTLING RATES OF CONCENTRATED SUSPENSIONS OF URANIUM DIOXIDE IN SODIUM. Alexander Sesonske (Los Alamos Scientific Lab., N. Mex.). Aug. 14, 1961. Contract W-7405-eng-36. 15p.

Hindered settling rates were measured at 500°C for suspensions in sodium of dense UO₂ in the concentration range of 10 to 30 vol % solids. The data as correlated by Steinour's solidity function indicated agglomeration with a ratio of volume of liquid envelope to volume of solids equal to 1.2. Supplementary room temperature measurements with suspensions of UO₂ in either acetone or benzene gave similar results with a liquid envelope solid volume ratio of 0.8. (auth)

29704 (LMSD-800257) LMSD BERYLLIUM EVALUATION PROGRAM. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Oct. 15, 1960. Contract NOrd 17017. 23p.

A catalog of all Polaris Missile System-sponsored and -directed evaluations on Be up to but excluding the fabrication development phase is presented. The scope and nature of each test or evaluation is described. (J.R.D.)

29705 (MLM-1081) PHASE EQUILIBRIA IN THE NaF-BeF₂-UF₄ TERNARY FUSED SALT SYSTEM. J. F. Eichelberger, C. R. Hudgens, L. V. Jones, G. Pish, T. B. Rhinehammer, P. A. Tucker, and L. J. Wittenberg (Mound Lab., Miamisburg, Ohio). [1960?]. Contract AT(33-1)-GEN-53. 62p.

The phase equilibrium diagram presented for the ternary fused-salt system NaF-BeF₂-UF₄ is based on evidence from differential thermal analysis, polarizing light microscopy, and x-ray examination of small samples obtained from thermal gradient quenching experiments, and from high-temperature filtration experiments. All the stable compounds in the binary systems NaF-BeF₂ and NaF-UF₄ displayed primary phase fields in the ternary system, including a new subsolidus compound which was observed and tentatively assigned the formula, NaF-4UF₄. No ternary compounds or solid solutions were formed. The following three eutectics were found in the ternary system: 72.5 (mole %) NaF - 17.0 BeF₂ - 10.5 UF₄, 485°C; 56.0

(mole %) NaF - 43.5 BeF₂ - 0.5 UF₄, 339°C; and 43.5 (mole %) NaF - 56.0 BeF₂ - 0.5 UF₄, 345°C. (auth)

29706 (NAA-SR-4244(Del.)) PROPERTIES OF ZIRCONIUM HYDRIDE AND ZIRCONIUM-URANIUM ALLOY HYDRIDES. S. M. Toy and J. B. Vetrano (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1, 1960. Decl. with deletions Sept. 29, 1960. Contract AT-11-1-GEN-8. 17p.

An investigation was undertaken of the physical, mechanical, and chemical properties of zirconium hydride, and zirconium-uranium alloy hydrides, and of combinations of these with fuel element structural materials. Results are reported of determinations of compatibility, dissociation pressure, density, crystal structure, electrical properties, thermal conductivity, thermal expansion, thermal migration, elastic modulus, ultimate tensile strength, and compressive strength. (auth)

29707 (NAA-SR-6427) OXYGEN DIFFUSION IN BERYLLIUM OXIDE. S. B. Austerman, R. A. Meyer, and D. G. Swarthout (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 15, 1961. Contract AT-11-1-GEN-8. 24p.

Polycrystalline BeO diffusion samples were prepared with a surface layer of BeO¹⁸. The samples were annealed at 1600 to 1900°C to allow the O¹⁸ to diffuse inward. The samples were analyzed by a sectioning technique, with determination of the O¹⁸/O¹⁶ ratio by vacuum fusion and mass spectrometric methods. The O¹⁸ concentration profile revealed two (and possibly three) data regions, indicating a complex oxygen diffusion process in BeO. Comparison of net O¹⁸ diffusion transport with Be transport in nearly identical samples indicates O to be several orders of magnitude slower, in partial qualitative agreement with recent data on sintering kinetics of BeO powder. (auth)

29708 (NAA-SR-Memo-2587) NUCLEAR PARAMETER SURVEY OF MOLYBDENUM-URANIUM ALLOY FUELS FOR THE SHELDON REACTOR. R. A. Blaine (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 28, 1958. 27p.

A parameter survey was conducted on 19-rod fuel clusters using 3 and 10 wt.% Mo-U alloys. Graphs are included for the core diameter and initial conversion ratio for $k_{eff} = 1.064$ as a function of moderator can size, and for the effect of the Mo resonance integral. (D.L.C.)

29709 (NASA-TN-D-806) THE BEHAVIOR OF BERYLLIUM AND BERYLLIUM COPPER IN A 4000°F SUPERSONIC AIR JET AT A MACH NUMBER OF 2. William H. Kinard (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.). May 1961. 8p.

Supersedes declassified NACA RM L57G31.

An investigation was conducted in a 4000°F supersonic air jet at Mach 2 to investigate the behavior of beryllium and beryllium copper. Results of these tests indicate that the beryllium is superior to beryllium copper as a heat-sink material. (auth)

29710 (NP-10618) MIGRATION AND EFFECTS OF COPPER IN P-TYPE BISMUTH TELLURIDE. Technical Report 376. Oscar P. Manley (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Sept. 1, 1960. Contracts Nonr-1841(51) and DA36-039-sc-78108. 37p.

The effects of copper on p-type Bi₂Te₃ were studied by examining the changes in resistivity and thermoelectric power induced in samples placed in intimate contact with copper. The experimental results were used to estimate

the over-all change in the electrical transport parameters, e.g., carrier mobilities, and effective masses, between the limits of no copper present and full compensation. Because of analytical difficulties, it was not possible to determine such changes for intermediate degrees of doping. Furthermore, the data for the regions in which the host lattice was overcompensated indicated that a chemical change was taking place; therefore, any interpretation of the experimental results in terms of simple doping did not seem plausible. An interpretation of the measurements allowed the activation energy for diffusion of Cu in the direction parallel to the cleavage planes to be measured; the results were found to be in agreement with those reported by others. (auth)

29711 (NP-10638) PROPERTIES OF BETA TITANIUM, TITANIUM-VANADIUM, AND TITANIUM-ALUMINUM ALLOYS: AN ANNOTATED BIBLIOGRAPHY. Helen M. Abbott, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). June 1961. Contract NORD 17017. 118p. (SB-61-31)

Included are 269 references to conference papers, reports, and U. S. and foreign journals and patents published from 1958 to June 1961. Abstracts are given for most of the references. (P.C.H.)

29712 (NP-10656) INVESTIGATION OF HIGH TEMPERATURE RESISTANT MATERIALS. Quarterly Report No. 21, May 1, 1961 to July 31, 1961. N. E. Poulos, S. R. Elkins, and J. D. Walton (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract NOrd-15701. 70p.

Revised aluminum chloride impregnating and firing procedures for slip-cast fused silica test bars resulted in bulk cristobalite contents of less than 2% for one or two impregnating and firing cycles, with a content of 4.2% for the fired product after three cycles. Procedures used for flame spraying alumina onto slip-cast fused silica are described. Several annealing procedures were investigated to determine the best procedure for glazing slip-cast fused silica. Transverse strength, total shrinkage, bulk cristobalite content, and surface porosity were determined. Studies were continued to determine the possibility of sealing surface voids of slip-cast fused silica with suitable ceramic glaze materials by flame spraying. Preliminary thermal expansion determinations were made for several compositions under study. Thermal shock studies were made on unglazed cylinders to determine possible causes of thermal shock failure. Preliminary results indicated no failures in those samples whose surfaces were treated by sanding with 60-grit silicon carbide cloth. A study was initiated to investigate the degree of melting of alumina particles in the arc-plasma torch. Work on fabricating several radome shapes was initiated. Plastic specimens were tested in the exhaust gases of the oxyhydrogen rocket motor. (M.C.G.)

29713 (NP-10666) INVESTIGATION OF DIFFUSION BARRIERS FOR REFRACTORY METALS. Progress Report No. 7, April 15 to July 15, 1961. (Manufacturing Labs., Inc., Cambridge, Mass.). July 25, 1961. Contract AF33 (616)-6354. 27p.

Screening studies at 1700°C were continued on base-barrier combinations. The Nb-Hf combination exhibited a degree of interdiffusion beyond the arbitrary limit for promising combinations. Comparison of the interdiffusion behavior of the Nb-Re combination with that of combinations of Re barriers and Nb-alloy base metals showed no significant change due to alloying of the Nb. On the other hand, the presence of Ti in the Mo + 0.5 Ti alloy apparently

resulted in a decrease of the extent of interdiffusion with Re, as compared to unalloyed Mo base metal. Comparison of the extent of interdiffusion in 5 combinations of barrier metals with the coating metal, Cr, showed that the Re-Cr combination exhibited the least interdiffusion. Interdiffusion studies in the 3-layer combinations of Mo-Re-Cr and Mo-Ir-Cr indicated that the presence of a barrier can reduce the extent of interdiffusion between the Mo base and the Cr coating by up to 75%. (auth)

29714 (NP-10684) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Aug. 1961. 50p.

A bibliography of 78 references with appended abstracts is presented on high-strength alloys, light metals, non-metallics, refractory metals, coatings, applications, and composites. (D.L.C.)

29715 (NP-10692) INVESTIGATION OF REFRACTORY METAL BERYLLIDES AND SILICIDES AS VERY HIGH TEMPERATURE MATERIALS. Progress Report No. 7, April 1, 1961-June 30, 1961. Technical Report No. 223-222. Jonathan Booker, Robert M. Paine, and A. James Stonehouse (Brush Beryllium Co., Cleveland). July 15, 1961. Contract AF33(616)-6540. 27p.

The investigation of refractory metal beryllides and silicides for very high temperature (>2500°F) applications for short-time use, 10 hours or less, was continued. Some of the properties of Ta_2Be_{17} and WSi_2 as a function of stoichiometry, particularly in the intermediate temperature region, are reported and discussed. Tests included modulus of rupture, thermal shock, and oxidation resistance measurements. The first of a series of vapor pressure measurements on selected beryllides using a direct weighing Knudsen cell technique is reported for $ZrBe_{13}$. Also, a preliminary analysis of Zr_2Be_{17} oxide scales for products is reported. (auth)

29716 (ORNL-3160) METALLURGY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 31, 1961. (Oak Ridge National Lab., Tenn.). Aug. 17, 1961. Contract W-7405-eng-26. 207p.

Fundamental Alloying. Studies of crystal structures, reactions at metal surfaces, spectroscopy of molten salts, mechanical deformation, and alloy theory are reported.

Long-Range Applied Metallurgy. A thermal comparator is described and the characteristic temperature of UO_2 determined. Sintering studies were carried out on ThO_2 . The diffusion of sintering products in fuel and of Al^{26} and Mn^{54} in Al and the reaction of Be with UC were studied. Transformation and oxidation data were obtained for a number of Zr alloys. Reactor Metallurgy. A large number of ceramic technology projects are described. Some corrosion data are given for metals exposed to impure He and molten fluorides. Studies were made of the fission-gas-retention properties of ceramic fuel bodies. A large number of materials compatibility studies are described. The mechanical properties of some reactor materials were studied. Fabrication work was conducted to develop materials for application in low-, medium-, and high-temperature reactors or systems. A large number of new metallographic and nondestructive testing techniques are reported. Studies were carried out on the oxidation, carburization, and stability of alloys. Equipment for postirradiation examination is described. Preparation of some alloys and dispersion fuels by powder metallurgy methods was studied. The development of welding and brazing techniques for reactor materials is described. (D.L.C.)

29717 (ORNL-3177) SORPTION OF URANIUM ON ZIRCONIUM OXIDE. Gerald Goldstein (Oak Ridge National Lab., Tenn.). Sept. 13, 1961. Contract W-7405-eng-26. 28p.

The sorption of the ions of uranium, copper, and nickel on hydrous zirconium oxide was investigated at temperatures from 25 to 250°C. The experiments were performed by equilibrating 5 ml of the test solution with 0.5 g of zirconium oxide in a titanium autoclave, which was heated by means of a rocking furnace. The sorption of uranium was affected by characteristics of the zirconium oxide, temperature of equilibration, and concentrations of uranium and of free acid in the uranyl sulfate solutions. Conclusions are drawn concerning the relationship between each of these factors and uranium sorption. (auth)

29718 (TID-7614) PROCEEDINGS OF THE SYMPOSIUM ON URANIUM CARBIDES AS REACTOR FUEL MATERIALS HELD AT ATOMIC ENERGY COMMISSION HEADQUARTERS BUILDING, GERMANTOWN, MARYLAND, APRIL 4, 1961. (Division of Reactor Development, AEC). 156p.

Five papers are included. Separate abstracts were prepared for each. (J.R.D.)

29719 (TID-7614(p.66-92)) POWDER METALLURGY OF URANIUM MONOCARBIDE. M. Korchynsky (Union Carbide Metals Co., Niagara Falls, N. Y.).

Effects of UC synthesis methods on the properties of resulting powders are discussed. Methods of cold compacting are reviewed and parameters of solid-state sintering are examined. High temperature structural and chemical changes are discussed, and the possibilities of lowering the sintering temperature are considered. (J.R.D.)

29720 (TID-13495) DIFFUSIONLESS PHASE CHANGES IN NON-FERROUS METALS AND ALLOYS. Technical Progress Report, July 1, 1960-July 31, 1961. T. A. Read, D. S. Lieberman, H. Fara, D. Gupta, B. G. Koepke, H. M. Ledbetter, K. Mukherjee, and R. L. Patterson (Illinois Univ., Urbana). Aug. 8, 1961. Contract AT(11-1)-67. 95p. (MEDUI-7-AEC)

Self-Diffusion in β -Phase Ordered Alloys of Au-Cd. Au^{196} , Cd^{115} , and Cd^{109} tracers were used to measure self-diffusion coefficients in Au-Cd alloys containing 47.5, 49.0, and 50.5 at.% Cd. The self-diffusion data were found to be strongly composition-dependent. The ratio D_{Cd}/D_{Au} was both composition- and temperature-dependent and varied from 1.6 to 0.6. The data are in agreement with the vacancy mechanism of diffusion and with the sequence of six elementary jumps mechanism proposed for ordered alloys. The Phase Change in BiMn. A crystallographic study was made of the first-order phase change occurring at ~360°C in BiMn. The results are consistent with the phase transformation being a martensitic reaction, although no lattice invariant shear was observed directly. The irreversible length and volume changes are explained in terms of point defects. Near-Equiatomic Ru-V Alloys. Metallographic, resistivity, and magnetic susceptibility measurements were carried out on Mn-Bi alloys containing 49.8 and 50.2 at.% Ru. The results are consistent with a first-order magnetic phase transformation accompanied by only slight changes in the tetragonality of the unit cell. (D.L.C.)

29721 (TID-13496) TRANSFORMATION CHARACTERISTICS OF ZIRCONIUM-NIOBIUM ALLOYS. Interim Technical Report No. 4. D. J. Cometto, G. L. Houze, Jr., and R. F. Hehemann (Case Inst. of Tech., Cleveland). July 31, 1961. Contract AT(11-1)-588. 54p.

A broad survey of the isothermal and quench-aging

transformations in alloys containing 12, 17.5, and 25% niobium was completed. The influence of alloy content and mode of heat treatment on transformation kinetics is compared. Major emphasis was placed on the structure and kinetics of the omega reaction. Previous studies revealed two forms of omega—to be termed quenched and aged omega. It was demonstrated that quenched-omega forms in a diffusionless manner where beta is cooled below a certain temperature, to be called ω_s . The temperature decreases from about 465°C in an alloy with 7.5% niobium to slightly above room temperature at the 25% niobium level. While quenched omega is supersaturated and has a composition determined by the alloy, aged omega has a very low niobium content and exists in metastable equilibrium with an enriched beta. The transformation of beta to quenched omega appears to be completely reversible over a broad temperature range with virtually no hysteresis. This most unusual characteristic has many far reaching implications. For example, it is intimately associated with the negative temperature coefficient of resistivity observed in the 17.5% niobium alloy and clarifies the seemingly pronounced and complex influence of composition on the aging of beta. An analysis of the diffuse diffraction effects associated with quenched omega is in progress. It has become apparent that these effects do not result simply from small particle size and that atom movements are more complicated than those pictured in existing models of this transformation. Quenched omega can be described by the hexagonal cell employed for aged titanium alloys; however, the atom positions in this cell are (000), $\pm (1/3, 2/3, U)$ where U is different from rather than equal to $1/2$ as in the case for aged omega in both titanium and zirconium alloys. The intensity of different omega reflections (all from the same orientation) cannot be described by a single U value. (auth)

29722 (WADD-TR-60-450) CORRELATION OF TENSILE PROPERTIES OF STEEL CASTINGS AND MATERIAL IMPERFECTIONS AS DETERMINED BY RADIOGRAPHY. L. J. Mattek and R. D. Woodward (Convair, San Diego, Calif.). Oct. 31, 1960. Contract AF33(616)-6622. 307p.

The relationships between tensile properties of 410 stainless-steel castings and imperfections, as determined by radiography, were investigated. The purpose was to establish confidence in a system of evaluating castings by radiographic inspection. Tensile properties investigated were: tensile yield, tensile ultimate, elongation, and modulus of elasticity; imperfections were: gas holes, inclusions, and porosity; thicknesses were: 0.1, 0.2, 0.3, and 0.6". Test specimens were heat treated to a 180,000 to 200,000 psi. Statistical analysis of test results is presented. Relationships between tensile properties and size or intensity of imperfections are represented in tables and graphs. (auth)

29723 (WAL-TR-320.1/3) AUSTEMPERED-AND-RETEMPTED VERSUS QUENCHED-AND-TEMPERED STEEL AT HIGH YIELD STRENGTH LEVELS. S. V. Arnold (Watertown Arsenal Labs., Mass.). July 1961. 37p.

Tensile properties, including notched-tensile and sustained-notched-tensile strength, and impact transition behavior of a 0.60% carbon silicon-rich tool steel were determined at 220,000 and 245,000 psi yield-strength levels to compare effects of austemper-and-retemper heat treatment practice with those of conventional quench-and-temper practice. At the 220,000 psi yield-strength level, no appreciable difference in properties was obtained for either heat treatment. At the 245,000 psi yield-strength level, ductility and notched-tensile strength were com-

parable, but austempered-and-retempered steel differed from the quenched-and-tempered in two respects: the former practice engendered not only a higher Charpy impact energy for ductile fracture but also a higher transition temperature; and the former practice induced substantially higher strength (275,000 psi compared to 225,000 psi for 150 hr duration in the presence of a $K_t = 6.3$ notch). (auth)

29724 (WAPD-T-1228) PRESSURE-DEFLECTION AND FATIGUE PROPERTIES OF ZIRCALOY DIAPHRAGMS. W. F. Losco, R. Leggett, R. Lacerte, F. O. Bingman, and C. R. Woods (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). July 1960. Contract AT-11-1-GEN-14. 63p.

Presented at the AIME Nuclear Metallurgy Symposium, Philadelphia, October 19, 1960.

Plate type fuel elements containing compartmented and unbonded ceramic fuel are of considerable interest because of their high thermal performance and long life capabilities. The unbonded Zircaloy cladding over individual fuel compartments in the plates are essentially thin diaphragms, fixed at the edges, and are subject to deformation under the action of hydrostatic pressure. The pressure-deflection and fatigue characteristics of such diaphragms, under a variety of out-of-pile temperature and pressure conditions, were determined and are described. (auth)

29725 (AEC-tr-4465) ANALYSIS OF URANIUM FUEL ROD BY X-RAY INVERSE POLE FIGURE METHOD (I). STUDIES ON URANIUM FUEL ELEMENT. PART VI. Kiyoaki Taketani. Translated from J. At. Energy Soc. Japan, 2: 190-5(1960). 15p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, Abstract No. 15080.

29726 (AEC-tr-4795) STUDY OF THE $\alpha \rightleftharpoons \beta$ PHASE CHANGE OF A URANIUM LOW-PERCENT CHROMIUM ALLOY. J. Beaudier, G. Cabane, and P. Mouturat. Translated by Myra Scott Feldman for Savannah River Lab., Aiken, S. C. from Rev. met., 58: 176-82(Mar. 1961). 20p.

The mechanism of the $\alpha \rightleftharpoons \beta$ phase change in U-0.6 at.% Cr alloys was studied by investigating the effects of the $\beta \rightarrow \alpha$ transformation on the resulting α structure and the effects of the $\alpha \rightarrow \beta$ transformation on the transformation temperature and crystal texture. (D.L.C.)

29727 (AEC-tr-4800) CRYSTAL STRUCTURE AND PHYSICAL PROPERTIES. A. E. Van Arkel. Translated by Jan Zandhuis and Gordon R. Love (Carnegie Inst. of Tech., Pittsburgh) from Physica, 4: 286-301(1924). 14p.

Kossel's conceptions of pure heteropolar lattices and homopolar lattices of heteropolar molecules are used to explain trends in crystalline compounds. Data on the crystal structure are presented and discussed for the following compounds: TiN, TiC, ZrN, ZrC, TaC, TaN, ZrO₂, ThO₂, UO₂, SrF₂, ZrS₂, and ZrSe₂. (D.L.C.)

29728 (DEG-Inf-Ser-214) USE OF TEMPERATURE AND PARAMETRIC DEPENDENCES OF LONG-TERM STRENGTH. N. N. Geminov. Translated by M. McCarthy for U.K.A.E.A., Risley, Lancs, Eng. from Metalloved-i Termicheskaya Obrabotka Metal., No. 9, 19-22(1959). 6p.

A discussion is given of an analysis and a comparison of prevailing parametric dependences without examining their physical bases, and an analysis of data on the temperature dependence of long-term strength of heat-resistant materials. (B.O.G.)

29729 (NP-tr-733) INVESTIGATING HEAT- AND ELECTRO-CONDUCTION OF TUNGSTEN AND GRAPHITE

AT HIGH TEMPERATURES. V. S. Gumenyuk and V. V. Lebedev. Translated from *Fiz. Metal. i Metalloved.*, 11: No. 1, 29-33 (Jan. 1961). 8p.

The equipment built for determining the coefficient of heat conductivity, electric conductivity, and their ratios for metals and alloys at temperatures between 900 and 2200°C. Data are presented on the temperature dependence of the heat conductivity and specific electrical resistance of tungsten and graphite. The values of the Wiedemann-Frantz ratio are also given. Empirical formulas are presented for the calculations of heat conductivity in relation to the temperature. The coefficients of heat conductivity of both tungsten and graphite decreased with an increase in temperature. Their progression was described by curves of the second magnitude over the entire investigated range. (M.C.G.)

29730 (NP-tr-739) INTERPRETATION OF THE MAGNETIC AFTER-EFFECT AT HIGH TEMPERATURES IN IRON-SILICON ALLOYS (TRANSFORMER SHEET). H.-D. Dietze. Translated by R. Hardbottle for U.K.A.E.A., Atomic Energy Research Establishment, Harwell, Berks, Eng. from *Tech. Mitt. Krupp*, 17: No. 2, 1-15 (1959). 66p. (Includes original, 6p.). (Handwritten MS. copy).

The anomaly in the initial permeability of Fe-Si systems above 300°C is interpreted in terms of diffusion of lattice vacancies into the Bloch wall. The activation energy (3.3 ev) determined therefrom agrees closely with that in pure Fe. In addition, the energy of formation (0.9 ev) and the activation energy of migration (2.4 ev) of the vacancies can be determined separately. The vacancies have a great effect upon the crystal energy. (auth)

29731 THE CRYSTAL STRUCTURE OF Ti_5Te_4 . F. Grønvald, A. Kjekshus, and F. Raaum (Universitetet i Oslo, Blindern, Norway). *Acta Cryst.*, 14: 930-4 (Sept. 10, 1961).

One of the phases in the titanium-tellurium system is identified as Ti_5Te_4 . This compound is tetragonal with 10 Ti and 8 Te in the body-centered cell with dimensions $a = 10.164$, $c = 3.7720$ Å. The space group is $I4/m-C_{4h}^2$ and the atomic positions are: (0, 0, 0; $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$) +; 2 Ti in (a) 0, 0, 0; 8 Ti in (h) x , y , 0; \bar{x} , \bar{y} , 0; \bar{y} , x , 0, y , \bar{x} , 0, with $x_1 = 0.3144$, $y_1 = 0.3752$; and 8 Te in (h) with $x_2 = 0.0589$, $y_2 = 0.2797$. The relationships between the Ti_5Te_4 -structure and the NiAs-like structure of the $Ti_{2-x}Te_2$ -phase are discussed. (auth)

29732 EXPERIMENTAL ATOMIC SCATTERING FACTORS AND ANOMALOUS DISPERSION CORRECTIONS FOR Th, U, AND Pu. R. B. Roof, Jr. (Los Alamos Scientific Lab., N. Mex.). *Acta Cryst.*, 14: 934-40 (Sept. 10, 1961).

Experimental atomic scattering factors were determined for Th, U, and Pu with Mo $K\alpha$, Cu $K\alpha$, Fe $K\alpha$, and Cr $K\alpha$ x radiations. The Thomas-Fermi-Dirac scattering curves were used as a theoretical basis, and the difference between the experimental and TFD curves was taken as a measure of the anomalous dispersion correction. As a result of determining the scattering factors for Th, U, and Pu from experimental samples of ThO_2 , UO_2 , and PuO_2 , the scattering factor for oxygen was also determined. The experimentally derived scattering curve for oxygen is in good agreement with the theoretical scattering curve for oxygen according to McWeeney. Calculated values for $\Delta f'$ and $\Delta f''$, the real and imaginary portions of the anomalous dispersion correction are compared with experimental values for these quantities. Agreement can be described as semi-quantitative since the experimental terms are of

the same order of magnitude and have the same signs as those indicated by theory. (auth)

29733 GADOLINIUM AND DYSPROSIUM INTERMETALLIC PHASES. I. THE CRYSTAL STRUCTURES OF DyGa AND GdPt AND THEIR RELATED COMPOUNDS. N. C. Baenziger and J. L. Moriarty, Jr. (Univ. of Iowa, Iowa City). *Acta Cryst.*, 14: 946-7 (Sept. 10, 1961).

The intermetallic phases DyGa, DyGe, GdGa, and GdGe are isostructural with the CrB structure type. The phases GdPt, DyPt, GdNi, and DyNi have structures which are only slight distortions of the FeB structure type. The structures were determined by a combination of single crystal and powder methods. (auth)

29734 GADOLINIUM AND DYSPROSIUM INTERMETALLIC PHASES. II. LAVES PHASES AND OTHER STRUCTURE TYPES. N. C. Baenziger and J. L. Moriarty, Jr. (Univ. of Iowa, Iowa City). *Acta Cryst.*, 14: 948-50 (Sept. 10, 1961).

Unit-cell dimensions and interatomic distances are given for the following phases: $MgCu_2$ type: GdX_2 and DyX_2 where $X = Pt, Mn, Fe, Co, Ni$ and Al ; $CsCl$ type: GdX and DyX where $X = Ag, Cu, In, Tl$ and Al ; $AuCu_3$ type: $GdIn_3$, $DyIn_3$, $DyTi_3$, $DyPt_3$; $MoSi_2$ type: $GdAg_2$, $DyAg_2$, $GdAu_2$, $DyAu_2$; $CuTi_3$ type: Dy_3In ; $CaZn_5$ type: $GdNi_5$, $DyNi_5$, $GdCo_5$, $DyCo_5$; AlB_2 type: $GdGa_2$, $DyGa_2$; $SnNi_3$ type: $GdAl_3$. (auth)

29735 THE FRICTION OF HEATED BISMUTH. C. D. Niven (National Research Council, Ottawa). *Can. J. Phys.*, 39: 1264-72 (Sept. 1961). (NRC-6429)

An apparatus is described to measure the friction of heated bismuth at loadings up to 640 psi. A coefficient for pyrex glass on bismuth near its melting point of 0.13 was indicated as a fair average value although figures down to 0.1 were also obtained. On surfaces where the metal was molten a value of 0.06 was measured. While bismuth has ice-like friction qualities up to a point, there is no proof that bismuth disobeys Amontons' law at high loading in the manner that ice does. To account for this, the crystal structures of bismuth and of ice are compared. (auth)

29736 INVESTIGATION OF THE THERMODYNAMIC PROPERTIES OF THE CERIUM-LEAD, PRASEODYMIUM-LEAD, AND NEODYMIUM-LEAD SYSTEMS. P. P. Otopkov, Ya. I. Gerasimov, and A. M. Evseev (Moscow State Univ.). *Doklady Akad. Nauk S.S.S.R.*, 139: 616-17 (July 21, 1961). (In Russian)

The thermodynamic properties of the rare-earth alloys are not well known at present; phase diagrams are available only for portions of the Ce-Pb and the Pr-Pb systems and not at all for Nd-Pb. Measurements were made in the probable heterogeneous regions assumed to exist on the basis of similarity with the available La-Pb system. The activity of Pb in its alloys with the above-mentioned rare earth metals was determined from vapor pressure measurements of the alloy. The partial enthalpy and entropy values were calculated making use of known equations. The integral enthalpy values of the 3 systems differed only slightly, indicating that all the 3 rare earth elements react similarly with Pb. The negative value of the entropy of alloy formation indicates a strengthening of the interatomic bonds in the alloy. The error in the activity measurements was calculated to be 1%, in the enthalpy and entropy measurements 20 and 25%, respectively. The data confirmed the existence of 3 intermetallic compounds in the Nd-Pb system and of the compound CePb in the heterogeneous region, thus agreeing well with the similar compound of the La-Pb phase diagram. (TTT)

29737 IMPROVED FORMS OF INDUSTRIAL GRAPHITE. F. K. Earp, A. R. Ford, and R. K. Hurden (Morganite Carbon Ltd., [London]). *Engineering*, 192: 178-9 (Aug. 11, 1961).

A discussion is given of the various forms of graphite developed for industrial purposes and the requirements desired for applications in reactors and missiles. Properties are given for several carbon and graphite materials so that they may be compared. The economic aspects of choosing the most desirable graphite is briefly discussed. (N.W.R.)

29738 RARE EARTH SILICATES. II. CONSTITUTION DIAGRAM OF BINARY $Gd_2O_3-SiO_2$ SYSTEMS. N. A. Torpov, F. Ya. Galakhov, and S. F. Konovalova (Inst. of Silicate Chemistry, Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk*, No. 4, 539-43 (Apr. 1961). (In Russian)

Constitution diagrams were prepared for binary $Gd_2O_3-SiO_2$, and the oxyorthosilicate $Gd_2O(SiO_4)$, orthosilicates $Gd_4(SiO_4)_3$, and pyrosilicates $Gd_2Si_2O_7$ compounds were synthesized. The properties and liquidus points were analyzed. (R.V.J.)

29739 RARE EARTH SILICATES. III. CONSTITUTION DIAGRAM OF A BINARY $Y_2O_3-SiO_2$ SYSTEM. N. A. Torpov and I. A. Bondar (Inst. of Chemistry of Silicates, Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk*, No. 4, 544-50 (Apr. 1961). (In Russian)

The phase diagram was constructed, and the composition and temperature of $Y_2O_3-SiO_2$ eutectic points were determined. Three compounds: $Y_2O_3 \cdot SiO_2$, $Y_2O(SiO_4)$, $2Y_2O_3 \cdot 3SiO_2$, $Y_4(SiO_4)_3$, $Y_2O_3 \cdot 2SiO_2$, and $Y_2(Si_2O_7)$ were synthesized and analyzed. (R.V.J.)

29740 RESISTANCE OF TITANIUM-ZIRCONIUM SOLID SOLUTIONS AGAINST PLASTIC DEFORMATION AT VARIOUS TEMPERATURES. V. V. Glazova and N. N. Kurnakov. *Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo*, No. 3, 67-72 (May-June 1961). (In Russian)

The resistance to plastic deformation of the Ti-Zr system was studied for the purpose of developing high-grade creep-resistant alloys. Starting with pure iodide Zr and magnesiothermic Ti, alloys containing 5.5, 11.6, 18.4, 34.5, 44.0, 55.0, 61.5, 67.0, 75.0 and 82.5 atomic % Zr were prepared by levitation melting in purified He atmosphere. The hot hardness of the specimens was determined under a vacuum of 10^{-3} to 10^{-4} mm of Hg by an indentation test using a 1 kg load for 0.5, 5 and 50 minutes at 300, 400, 500, 600 and 700°C, soaking the specimens for 100 hours at the desired temperature before testing. Bending tests were also carried out at 500°C in air. A definite correlation has been established between the creep-composition diagram and the phase diagram of the system. The presence of regions with a structure close to a friable high-temperature modification (or to a liquid) was found to cause a sudden reduction of the resistance to plastic deformation. Allotropic transformations were found to play an important role in this respect; with a lowering of the transformation temperature, the location of this temperature zone will be reduced. (TTT)

29741 HEAT RESISTANCE PROBLEMS. M. Yu. Bal'shin and Shou-Huai Tai (Shou-hui Tai). *Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo*, No. 3, 73-6 (May-June 1961). (In Russian)

The mechanism of the phenomena caused by rapid, cyclic heat treatment of solids was investigated to confirm experimentally previously derived theoretical deductions.

According to this theory the thermally-induced stresses result either in alternating compression and elongation of the system leading to the reduction of the contact surface between components and to lower density, or to the formation of residual compression stresses of the order of 2 to 20 kg/cm² which cause increased contact and higher density. As a 1% change of the density corresponds to 3 to 15% change of the contact surface, instead of dilatometric or pycnometric methods a method based on the contact surface, namely electric resistance measurement, was used. This method presents the advantages of being non-destructive and easily reproducible. Graphite and solid oxide mixtures were used for the tests. Results confirmed the expectations: the cyclic heat treatment increased the resistance but in case of microporous specimens the resistance was considerably reduced, presenting an example of sintering and self-healing of defects. It was found that the heat resistance depends not only on the physical properties of the components but also on the shape and dimension of the test specimens. (TTT)

29742 CONTRIBUTIONS TO REVIEW OF THE DISCUSSION ON STRUCTURE AND PROPERTIES OF LIQUID METALS. V. M. Glazov, A. A. Vertman, and E. G. Shvidkovskii. *Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo*, No. 3, 104-15 (May-June 1961). (In Russian)

The correlation between the structure and the properties of liquid metals and those of the corresponding solid alloys is still only insufficiently explained. The change of interparticle forces during the transition from the solid to the liquid state, the influence of the crystalline structure on the properties of the system beyond the melting point, or the problem of the structural units of the liquid phase may be clarified with consideration of the molecular-kinetic theory of phase transformations. Although the close order of many liquid metallic systems reflects traces of the crystalline structure, the liquid system is not identical with the crystal and accordingly no close similarity of the properties may be expected. If one of the components changes only slightly, the character and the structure of the molten system will be more strongly dependent on the crystal structure than in case of components which undergo basic changes during the melting process, such as Ge, Si, Bi, Sb or Te. In this latter case there are negative deviations from ideal behavior, resulting in the absence of microinhomogeneities in the eutectic melt. The problems presented by chemical compounds in the liquid phase are still not solved and they require additional studies on the temperature dependence of the composition-property diagram for a larger number of alloy systems. (TTT)

29743 STUDY OF LIQUID METAL ALLOYS. F. Sauerwald (F. Zauervald). *Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo*, No. 3, 115-16 (May-June 1961). (In Russian)

It has been assumed that property isotherms do give a reliable indication on the occurrence of limited solubility or immiscibility in liquid eutectic systems. However, it has been found later that systems which have a limited solubility in the liquid phase exhibit positive coefficients of surface tension; this has been noticed even in cases in which the limited solubility region could not have been clearly defined and which showed their tendency toward such behavior only by the inflection of the liquidus curves. The appearance of the limited solubility probably coincides with the start of eutectic crystallization so that these systems may not be considered as being completely homogeneous. On the basis of these considerations the following classification is suggested: 1) V-systems containing a

compound with a stable intermetallic bond in the solid state which causes divergences in the property isotherm from the average values; 2) L-systems without a stable bond between the components (typical ideal solutions) having simple property isotherms; 3) E-systems exhibiting limited solubility in the liquid state resulting ultimately in the separation of the components; and 4) less sharply defined or intermediate Z-systems. However, this classification does not solve all the problems of systematization of liquid alloys. (TTT)

29744 CRYSTALLINE THORIUM BORATE. Y. Baskin, Y. Harada, and J. H. Handwerk (Illinois Inst. of Tech., Chicago and Argonne National Lab., Ill.). *J. Am. Ceram. Soc.*, 44: 456-9 (Sept. 1961).

Crystalline thorium borate (ThB_2O_5) was synthesized by the reaction of thorium with boric oxide at elevated temperatures; crystals suitable for single-crystal x-ray studies were grown in molten boric oxide at 1300°C. Crystallographic, chemical, and some physical properties of thorium borate crystals are presented as well as the results of a preliminary phase study of the system $\text{ThO}_2\text{-B}_2\text{O}_3$. Amorphous thorium borate gel, formed by reaction of aqueous solutions of borax and thorium nitrate, is transformed into crystalline thorium borate and thorium on firing at elevated temperatures. Boric oxide does not appear to react with either zirconium oxide or uranium dioxide to form any crystalline compounds. The fact that uranium dioxide does not react with boric oxide, but thorium does, affords a basis for effecting a chemical separation of the two oxides from thorium-uranium solid solutions. Preliminary data on the reactions between boric oxide and different thorium-uranium solid solutions are given. (auth)

29745 THE STRUCTURE OF SILVER OXIDE DETERMINED BY MEANS OF NEUTRON DIFFRACTION. Vladimiro Scatturin (Brookhaven National Lab., Upton, N. Y. and Università, Bari, Italy), Pier Luigi Bellon, and Alvin J. Salkind. *J. Electrochem. Soc.*, 108: 819-22 (Sept. 1961).

The crystal structure of Ag_2O was determined by means of neutron diffraction. The nuclear scattering of Ag and O atoms made it possible to determine the positions of the oxygen atoms, and to modify the space group which was reported for this compound from x-ray data. No magnetic diffractions were observed even at liquid helium temperature; the absence of magnetic scattering confirms the diamagnetism of the compound. The lattice was found to be monoclinic, space group $P 2_1/c$, with four formula weights of Ag_2O in the unit cell. The silver atoms are not equivalent, and in the structure there are two Ag-O distances of 2.18 Å and 2.03 Å; the first one corresponds to colinear Ag(I)-O bonds, the second distance corresponds to square planar Ag(III)-O bonds. (auth)

29746 THE CONSTITUTION DIAGRAM OF THE MOLYBDENUM-HAFNIUM BINARY SYSTEM. A. Taylor, N. J. Doyle, and B. J. Kagle (Westinghouse Electric Corp., Pittsburgh). *J. Less-Common Metals*, 3: 265-80 (Aug. 1961). (In English)

The molybdenum-hafnium binary system was determined. The body-centered cubic α -Mo primary solid solution extends to approximately 16.5 at.% Hf at 1000°C and 28 at.% Hf at 2165°C at which temperature it reacts peritectically with liquid to form $\epsilon\text{-Mo}_2\text{Hf}$, a hexagonal Laves phase of the $\text{C}_{36}\text{-Cu}_2\text{Mg}$ type. A eutectic forms at 1915°C between $\epsilon\text{-Mo}_2\text{Hf}$ and the high-temperature β -Hf body-centered cubic primary solid solution which extends to 58.5 at.% Hf at the eutectic temperature. Between 1910 and 1750° the $\epsilon\text{-Mo}_2\text{Hf}$ structure transforms to the cubic η

$\text{C}_{15}\text{-Cu}_2\text{Mg}$ form which reverts back to the original $\epsilon\text{-Mo}_2\text{Hf}$ C_{36} form below 700°C. β -Hf transforms martensitically to hexagonal close-packed α -Hf at 1950°C, the phase field of the latter being very narrow, ranging from approximately 99.2 to 100 at.% Hf. β -Hf decomposes eutectoidally at 73.5 at.% Hf and 1215°C to form $\eta\text{-Mo}_2\text{Hf} + \alpha\text{-Hf}$. (auth)

29747 CONSTITUTION STUDIES ON THE NEPTUNIUM-PLUTONIUM ALLOY SYSTEM. P. G. Mardon, J. H. Pearce, and J. A. C. Marples (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *J. Less-Common Metals*, 3: 281-92 (Aug. 1961). (AERE-R-3683). (In English)

Neptunium-plutonium alloys were examined over the complete range of compositions using thermal analysis, dilatometric, and x-ray techniques. The probable form of the constitution diagram was determined, the most noteworthy feature being the extremely high solubilities of neptunium in the monoclinic α and β phases of plutonium. An intermediate phase exists at high temperatures at the plutonium-rich end of the system; its crystal structure is complex but an orthorhombic cell was tentatively assigned to it with $a = 10.86$ Å, $b = 10.67$ Å, and $c = 10.43$ Å for a 19 wt.% neptunium alloy at 375°C. The relation of this cell to the cubic ξ -plutonium-uranium and δ -neptunium-uranium phases is discussed. γ -neptunium and ϵ -plutonium are completely miscible and by extrapolation of the high temperature lattice parameters a value of 3.518 Å was obtained for the γ -neptunium parameter at 500°C. There is appreciable solubility of plutonium in the α and β phases of neptunium, although the exact values are not known. The solidus shows a marked depression in the middle of the system and only varies slowly with composition over a large part of the diagram. (auth)

29748 PHASE EQUILIBRIA IN THE THORIUM-TANTALUM SYSTEM. O. D. McMasters and W. L. Larsen (Ames Lab., Ames, Iowa). *J. Less-Common Metals*, 3: 312-20 (Aug. 1961). (IS-283). (In English)

X-ray, electrical resistance, thermal, and metallographic methods were used to determine the phase diagram of the thorium-tantalum system. The diagram is of the simple eutectic type with a eutectoid reaction associated with the thorium α - β transformation. The eutectic point occurs at $1565 \pm 10^\circ\text{C}$ and 4.0 ± 0.5 wt % tantalum. No evidence of intermetallic compounds was found and only slight terminal solid solubility was found at either end of the diagram, even at elevated temperatures. The solubility of tantalum in thorium at the eutectic temperature is about 0.4 wt % and below 1340°C is less than 0.2 wt %. The solubility of thorium in tantalum was found to be less than 0.2 wt % at the eutectic temperature. (auth)

29749 THE CONSTITUTION DIAGRAM OF THE TUNGSTEN-OSMIUM BINARY SYSTEM. A. Taylor, B. J. Kagle, and N. J. Doyle (Westinghouse Electric Corp., Pittsburgh). *J. Less-Common Metals*, 3: 333-47 (Aug. 1961). (In English)

The constitution diagram of the refractory alloy binary system tungsten-osmium was determined using a combination of x-ray and micrographic techniques. The system contains three single-phase fields, namely: a body-centered cubic α -W primary solid solution which retains approximately 18.5 at % Os at the peritectic temperature of 2945°C , dropping to approximately 6 at % Os at 1200°C ; a tetragonal σ -phase which forms peritectically at 22 at % Os and at a temperature of 2945°C by reaction between α -W solid solution and liquid, the σ -phase field opening out and extending at 1200°C from 21 to 35 at % Os; and a hexagonal close-

packed terminal solid solution based on θ -Os, whose solid solubility limit ranges from 46 at % Os at the eutectic temperature of 2725°C to 68 at % Os at 1200°C. Lattice parameters were evaluated for α -, σ -, and θ -phase alloys along with their Vickers hardness values. Sigma-phase alloys were found to be extremely hard and brittle and scratch glass very easily. (auth)

29750 USE OF NICKEL-MOLYBDENUM ALLOYS FOR HANDLING OF CORROSIVE CHEMICALS. E. V. Zotova. *Khim. Mashinostroenie*, No. 4, 10-12(1960).

Corrosion tests carried out with hydrochloric and sulfuric acids at increased temperatures on samples of nickel-molybdenum and nickel-molybdenum-chromium alloys used for cold-rolled metal strips and thin-walled welded tubings are described. The chemical compositions of the tested alloys are given. Ingots of 17 kg were hammered, hot-rolled into 3-mm sheets, then cold-rolled into 1 × 200 mm and 6-m long strips, casehardened in water at 1150°C, and pickled to remove scale. The mechanical properties of strips after heat processing are given. Thin-walled welded tubings of 16 × 1 mm in diameter and a minimum length of 3 m were obtained by argon arc welding. The corrosion resistance of nickel alloys in sulfuric, hydrochloric, formic, and hydrobromic acids of various concentrations and temperatures was tested on samples of hot- and cold-rolled sheets and welded tubings. The adverse effect of chromium in nickel-molybdenum alloys in sulfuric acid of more than 30% and in hydrochloride acid was noted. The corrosion resistance of nickel-molybdenum alloys used for pumps and fittings in ethyl alcohol production by the sulfuric acid method was also tested. The operating medium for pumps consisted of 69.83% sulfuric acid, 1.8% water, up to 0.87% polymers, and 27.5% bound ethylene. The operating medium for the fitting was: 35.5% sulfuric acid, 43.5% water, 18% ethyl alcohol, 2.5% ether, and up to 0.5% polymer at temperatures to 105°C and pressures to 28 atm. Among four tested alloys only one alloy proved corrosion-resistant. (OTS)

29751 ON THE PRESS FORGING TECHNOLOGY FOR URANIUM AND URANIUM ALLOYS. I. L. Perlin and V. A. Fedorchenko. *Kuznechno-Shtampovochnoe Proizvodstvo*, No. 9, 12-18(1960).

A review of information on the technology of forging uranium is given. The information sources are American (A.I.M.E.), or in the English language, and include manuals, and the proceedings of two international conferences in Geneva (1955 and 1958). Two Soviet sources referred to are only mentioned. The first deals with peculiarities of pressing beryllium, zirconium, uranium, and thorium, and the latter with work safety. (OTS)

29752 RHENIUM. Metal Treatment and Drop Forging, 27: 294-5(July 1960).

Although rhenium has the highest melting point (3170°C) of the refractory metals, excluding tungsten (3380°C), it is still too scarce and expensive to be considered for general design applications. However, for many specialized applications such as use for a welding filler metal, thermocouples, filaments, and electrical contacts the use of rhenium-base alloys and other alloys rich in rhenium is justified by their outstanding properties. Some of the mechanical properties are presented. The metal has the following principal attributes: most refractory of the metals that can be electrodeposited from an aqueous solution, superior to tungsten in resistance to deterioration caused by the water cycle, low contact resistance, does not form stable carbides, greater ductility at room tempera-

ture than tungsten, and good thermoelectric properties when joined with tungsten or molybdenum. (N.W.R.)

29753 METALLURGY IN NUCLEAR POWER TECHNOLOGY. 3. PROPERTIES OF FISSILE AND BREEDER METALS. J. C. Wright (Coll. of Advanced Tech., Birmingham, Eng.). *Metal Treatment and Drop Forging*, 27: 375-85(Sept. 1960).

The characteristics and properties of the fissile and breeder metals and alloys of plutonium, thorium, and uranium are given. (N.W.R.)

29754 URANIUM-PLATINUM ALLOYS. Metal Treatment and Drop Forging, 27: 386; 385(Sept. 1960).

The crystal structure and phase studies of the platinum-uranium alloys are described. The phase diagram, correlated from thermal and metallographic analyses, and x-ray diffraction studies show that the system is characterized by four intermetallic compounds: UPt, UPt₂, UPt₃, and UPt₅. The behavior and properties of the various compounds are presented and discussed. (N.W.R.)

29755 METALLURGY IN NUCLEAR POWER TECHNOLOGY. VI. FUEL ELEMENT TECHNOLOGY. J. C. Wright (Coll. of Advanced Tech., Birmingham, Eng.). *Metal Treatment and Drop Forging*, 28: 109-13(Mar. 1961).

The performance of dispersed ceramic materials and the requirements necessary for a liquid fuel system and the fuel itself are discussed. Major discussions are on uranium carbides, uranium oxides, and other uranium dispersed systems. Plutonium combinations are also discussed as reactor fuels in both the dispersed and liquid form. (N.W.R.)

29756 EUROPIUM AND EUROPIUM ALLOYS. R. Lesser and E. Erben (W. C. Heraeus G.m.b.H., Hanau, Ger.). *Metall.*, 15: 30-3(Jan. 1961). (In German)

The properties of europium and its alloys were studied for use in the control of nuclear reactors because of its high absorption cross section for thermal and epi-thermal neutrons. The properties of europium are compared with B, Cd, Hf, Gd, and Sm for reactor control. The alloy Ag-Cd-Eu containing about 5 wt% Eu was found to fulfill to the greatest degree the requirements for a reactor control material and to also possess good corrosion resistance and machinability properties. (M.C.G.)

29757 AN X-RAY STUDY OF PHASE TRANSITIONS IN NaNbO₃. S. P. Solov'ev, Yu. N. Venetsev, and G. S. Zhdanov (Karpov Inst. of Physical Chemistry, USSR). *Soviet Phys.-Cryst.*, 6: 171-5(Sept.-Oct. 1961).

A detailed study is made of polycrystalline NaNbO₃ in the range from room temperature to 700°C. A new second-order phase transition is detected at 430°C; the subcell of NaNbO₃ is monoclinic in the range 360 to 430°C (NaNbO₃ is actually orthorhombic), the parameters being $a = c \approx b$, $\beta > 90^\circ$; this result agrees with optical evidence. Proof is obtained of a transition at 470°C. The symmetry of NaNbO₃ at -196°C is the same as that at room temperature. The relation of the dielectric parameters to the types of phase transitions is discussed. (auth)

29758 REVISION OF THE PHASE DIAGRAM FOR THE Bi-Rh SYSTEM. R. N. Kuz'min and N. N. Zhuravlev (Moscow State Univ.). *Soviet Phys.-Cryst.*, 6: 209-10(Sept.-Oct. 1961).

An analysis is made of the phases of the bismuth-rhodium alloys, in particular, the crystals of alpha Bi₂Rh, beta Bi₃Rh, and alpha Bi₄Rh. The results for alpha Bi₂Rh are reasonably reproducible no matter what the method of analysis; the mean value corresponds to the stoichiometric

composition (19.81 wt. % Rh). The results for beta Bi_3Rh agree with the x ray results (that the beta phase is Bi_3Rh not Bi_4Rh). The results for alpha Bi_4Rh deviate somewhat from the rational composition Bi_4Rh toward the enrichment in rhodium. The compositions of beta Bi_3Rh and alpha Bi_4Rh are 14.1 and 12.4 wt. % Rh, respectively. The process for isolating Bi_2Rh crystal and the transition temperature of this crystal are also discussed. (N.W.R.)

29759 DETECTION OF EDGE DISLOCATIONS IN GERMANIUM BY IONIC BOMBARDMENT. I. G. Sirotenko and G. V. Spivak (Moscow State Univ.). *Soviet Phys.-Cryst.*, 6: 213-15 (Sept.-Oct. 1961).

A method is described for detecting in germanium crystals small-angle grain boundaries consisting of edge dislocations, and also edge dislocations formed in a crystal by plastic deformation. The method is based on the bombardment of the specimen by accelerated heavy ions (cathode sputtering). The sputtering is carried out in a three-electrode tube in which the specimen, in the form of a probe having a high negative potential relative to the cathode (1 to 1.5 kv), is introduced into a plasma of low pressure and high current density. Sputtering is carried out by means of heavy ions of krypton. The density of the ionic current to the specimen is varied within the limits from 2 to 10 ma/cm². (N.W.R.)

29760 STRENGTHENING OF IRON-BASE ALLOYS CONTAINING COLUMBIUM. Ervin E. Underwood, Eugene M. Stein, and George K. Manning (Battelle Memorial Inst., Columbus, Ohio). *Trans. Met. Soc. AIME*, 221: 676-82 (Aug. 1961).

Niobium, carbon, and nickel additions were made to iron-base alloys with 20% Cr. The effects on microstructure, precipitation-hardening characteristics, and high-temperature properties were investigated by means of metallographic, hot-hardness, and magnetic measurements. An austenitic alloy consisting of Fe-20Cr-14Ni-0.8C-2.5Nb had higher hot-hardness at 1700°F than the other alloys investigated. Its favorable standing is attributed to an enhanced interaction of Nb and Cr_4C particles dispersed within a stable austenitic matrix. (auth)

29761 THE COLUMBIUM-OXYGEN EQUILIBRIUM IN LIQUID IRON. Michel Elle and John Chipman (Massachusetts Inst. of Tech., Cambridge). *Trans. Met. Soc. AIME*, 221: 701-3 (Aug. 1961).

The equilibrium of gaseous $\text{H}_2\text{O}-\text{H}_2$ mixtures with liquid Nb-Fe alloys in the range 0.2 to 2.4% Nb shows that the activity coefficient of oxygen is strongly diminished by Nb. The oxide in equilibrium with the melt is identified as NbO_2 . The equilibrium constant at 1600 deg C is $[\% \text{Nb}][f_0 \cdot \% \text{O}]^2 = 2.9 \times 10^{-4}$ where $\log f_0 = -0.14 [\% \text{Nb}]$. The deoxidizing power is comparable to that of vanadium. (auth)

29762 THE CADMIUM-URANIUM PHASE DIAGRAM. Allan E. Martin, Irving Johnson, and Harold M. Feder (Argonne National Lab., Ill.). *Trans. Met. Soc. AIME*, 221: 789-91 (Aug. 1961).

The cadmium-uranium system was studied by thermal, metallographic, x-ray and sampling techniques; special emphasis was placed on the establishment of the liquidus lines. The single intermetallic phase, identified as the compound UCd_{11} , melts peritectically at 473°C to form α -uranium and melt containing 2.5 wt. % uranium. The cadmium-rich eutectic (0.07 wt. % uranium) freezes at 320.6°C. Solid solubilities in uranium and cadmium appear to be negligible. Between 473°C and 600°C the liquidus line is retrograde. (auth)

29763 THE EFFECT OF INITIAL ORIENTATION ON THE FIBER TEXTURE OF ALUMINUM RODS. Carl J. McHargue (Oak Ridge National Lab., Tenn.). *Trans. Met. Soc. AIME*, 221: 812-19 (Aug. 1961).

Rods of 99.99 % Al which had initial orientations of <001>, <118>, <115>, <111>, and random were swaged at room temperature. Changes in orientation as a function of deformation were studied on axis distribution charts. The <001> orientation appeared to be relatively stable due to the inhomogeneity of the deformation process. Orientations near the <100> zone were quickly reoriented towards <001>. Orientations on the <110> zone between <118> and <115> appeared to be stable to reductions of about 50 pct, then were reoriented toward <001>. At very high reductions, movement away from the <111> orientation was observed. (auth)

29764 THE THERMAL DIFFUSION OF HYDROGEN IN ALPHA-DELTA ZIRCALOY-2. J. M. Markowitz (Westinghouse Electric Corp., Pittsburgh). *Trans. Met. Soc. AIME*, 221: 819-24 (Aug. 1961).

The movement of hydrogen in two-phase α - δ Zircaloy-2 under the influence of a thermal gradient was studied in specimens of cylindrical geometry. A gross displacement of hydrogen toward the cooler regions of the specimen was observed with consequent copious precipitation of δ -zirconium ($\text{ZrH}_{1.4}$) there. The kinetics of the diffusion are analyzed and discussed. (auth)

29765 SOLUTE SEGREGATION DURING DENDRITIC GROWTH. F. Weinberg (Dept. of Mines and Technical Surveys, Ottawa). *Trans. Met. Soc. AIME*, 221: 844-50 (Aug. 1961).

Measurements have been made of solute segregation during dendritic growth by using radioactive solute elements and measuring the activity of dendrites cut from decanted specimens. This has been done for both lead and tin based binary alloys containing the following solute additions: Ag^{110} , Ti^{204} , Zn^{65} , Sb^{124} , Sn^{113} , and Co^{60} . It was found that C_d/C_0 the ratio of the dendrite to matrix concentration, was dependent on k_0 , the equilibrium distribution coefficient in the following way. For $k_0 < 0.1$, $C_d/C_0 \approx 0.6$; for $k_0 > 0.1$, $0.6 < C_d/C_0 < 1$. Qualitative observations were made of dendritic segregation, by using autoradiographic techniques, for the Sn + Ag^{110} and Sn + Ti^{204} systems. The observations were found to be in general agreement with the measurements of C_d/C_0 . Autoradiographs were also obtained of sectioned dendrite stalks. These indicated that the stalks had a substructure, delineated by solute concentrations along the substructure walls. A new dendrite growth direction <111> is reported for tin. (auth)

29766 ORIENTATION OF CAST BERYLLIUM. F. A. Crossley, A. G. Metcalfe, and R. P. Elliott (Illinois Inst. of Tech., Chicago). *Trans. Met. Soc. AIME*, 221: 890 (Aug. 1961).

The texture method (utilizing monochromatic copper radiation) was applied to determine the orientation of the columnar grains of two vacuum-cast Be ingots 3 in. in diameter. The Debye pattern was compared with theoretical patterns for various orientations. No significant preference for the direction of columnar growth is indicated. It is considered that the lack of a preferred orientation is because of the occurrence of the phase transformation which masked the original solidification orientation. (L.T.W.)

29767 PROCESS FOR THE PREPARATION OF CARBON WITH HIGH MODERATING PROPERTIES AND THE USE THEREOF IN NUCLEAR REACTORS. Willem J. D.

Van Dijk (to Shell Oil Co.). Canadian Patent 623,993. July 18, 1961.

A simple, inexpensive process is outlined for preparing carbon with a small content of firmly bound deuterium. The process comprises treating finely divided carbon containing bound hydrogen with gaseous deuterium and/or deuterium compounds in a countercurrent manner at $\geq 500^\circ\text{C}$ and high pressure. (D.L.C.)

Radiation Effects

29768 (HW-68919) EXPERIMENTAL EVIDENCE OF FISSION FRAGMENT DAMAGE IN SOME METALS AND NONMETALS. T. K. Bierlein and B. Mastel (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 1961. Contract AT(45-1)-1350. 39p.

Electron microscopy of thin films and foils irradiated in close proximity to a fissionable source has permitted study of fission fragment damage in nonfissionable material. The interaction of fission fragments with material thin enough for transmission microscopy manifests itself as regions or tracks having a higher electron transparency than the matrix. Such damaged regions, approximately 150 \AA in diameter and less than five microns in length, appear to be a function of the material and the distance between the fission fragment and the free surface of the material. Results on typical evaporated multilayered films of the type carbon- UO_2 -X, and carbon-X- UO_2 before and after surface shadowing are presented, where X is the material of interest such as aluminum or platinum, and UO_2 is the source of fission fragments. Similar damage is reported in prethinned aluminum foils, in which discrete regions free of UO_2 show fission fragment tracks. Dislocations in irradiated, UO_2 -coated aluminum foils were observed to interact with fission fragment tracks. The importance of free surfaces on the damage introduced in bulk aluminum specimens by fission fragment bombardment is illustrated by surface replicas. (auth)

29769 (NAA-SR-Memo-6151) DESIGN CRITERIA AND EXPERIENCE IN NUCLEAR FUEL IRRADIATIONS. D. G. Harrington (Atoms International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 17, 1961. 59p.

The criteria for designing in-pile nuclear fuel experiments are described. Interrelated heat transfer, nuclear, safety, mechanical, and administrative problems were considered. Graphs are presented which allow rapid estimation of 16 design criteria for preliminary planning purposes. Illustrations of the experience accumulated in irradiations are given. (auth)

29770 (NOLTR-61-45) RADIATION DAMAGE THRESHOLDS FOR PERMANENT MAGNETS. R. S. Sery, R. H. Lundsten, and D. I. Gordon (Naval Ordnance Lab., White Oak, Md.). May 18, 1961. 49p.

Several sets of permanent magnets, representative of commercially important magnet materials, were irradiated to integrated neutron flux levels from 3×10^{17} to 4×10^{20} epicadmium n/cm^2 . In spite of this relatively high dose, Alnicos II, V and XII showed negligible change in properties whether irradiated at 60°C , 235°C , or 325°C . Cunico I, though affected, showed changes less than a threshold of radiation damage of $\pm 10\%$. Cunife I and $3\frac{1}{2}$ Chromium Steel showed slight improvements in properties. The barium ferrites, Silmanal, 36 Cobalt Steel and others exceeded the 10% damage threshold by various amounts which extended up to severe demagnetization. Differentiation between temperature and radiation effects was ac-

complished by the use of control magnets, and by the 60°C irradiation. Limitations on the use of Alnicos II, V, XII and Cunico I in combined heat and nuclear radiation environments may be imposed by the higher vulnerability of associated soft magnetic circuit components, e.g., pole pieces of soft iron, to radiation damage and by high gamma heating which can occur if a magnetic circuit must be used in a sealed container. Of the two most widely used groups of permanent magnets, the Alnicos exhibit the highest resistance to radiation, while the barium ferrites show the least. (auth)

29771 (NP-10623) THE EFFECTS OF HIGH ENERGY RADIATION ON INFRARED OPTICAL MATERIALS. AN ANNOTATED BIBLIOGRAPHY. George R. Evans and William E. Price, comps. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). May 1961. Contract AF04(647)-564. 47p. (SB-61-25)

References (88) are given to reports and U. S. and foreign journals published from October 1949 to February 1961 on the effects of high-energy radiation on the infrared and other optical properties of germanium, silicon, silica, glass, and quartz. A corporate author index is also included. (P.C.H.)

29772 (NP-10651) INTERNAL FRICTION AND MODULUS BEHAVIOUR OF GAMMA-IRRADIATED NaCl CRYSTALS. Technical Report No. 4. J. M. Sivertsen (Minnesota. Univ., Minneapolis). July 17, 1961. Contract Nonr 710(29). 19p.

The internal friction and modulus of single crystals of NaCl were measured during the irradiation of the sample by Co^{60} gammas. Since the strain amplitude-independent internal friction is at present only explained in terms of the pinned dislocation theory a test of the theory is important. In the present investigation, the time dependence of the decrement and modulus are considered useful criteria for the validity of the theory. This follows from the loop length dependence of the decrement and $\Delta E/E$. The generation of point defects during gamma irradiation results in the pinning of dislocation loops of the network due to the interaction between the point defects and dislocations. If it is assumed that n the number of pinning points is the sum of the number before and those produced during irradiation the formula $n = \Lambda/L = \Lambda/L_0 + \alpha t$ can be written where L_0 is the loop length before irradiation and Λ is the total dislocation length per unit volume. A characteristic time dependence results during irradiation. Results are discussed in terms of this model. (auth)

29773 (NP-10688) DEVELOPMENT OF RUBBER GASKETS WHICH ARE RESISTANT TO NUCLEAR RADIATION. Final Report. Report No. 149-4. R. E. Morris (Mare Island Naval Shipyard. Rubber Lab., Calif.). Feb. 28, 1961. 55p.

Gamma irradiation effects on vulcanized rubbers (vulcanizates) are studied for doses up to 10^9 r . The tendency of vulcanizates to undergo compression set, when exposed to radiation while under compression, is chosen as a measure of the effect of the radiation. The radiation effects are smallest on vulcanized natural rubber, styrene/butadiene copolymers, and acrylonitrile/butadiene/methacrylic acid terpolymers. The resistance of these vulcanizates to radiation can be increased by compounding the rubbers with certain antioxidants or antiozonants, and/or with certain chemicals containing aromatic rings or condensed ring structures. The resistance of a styrene/butadiene vulcanizate to radiation is increased by the use of dicumyl peroxide instead of sulfur as the vulcanizing agent. (T.F.H.)

29774 (NRL-5686) THE EFFECTS OF IRRADIATION ON MAGNETIC PROPERTIES OF ALLOYS AND FERRITES. A. I. Schindler (Naval Research Lab., Washington, D. C.). Aug. 11, 1961. 37p.

Studies were conducted on the effects of neutron irradiation on the magnetic characteristics of metal alloys and ferrites. The magnetic properties examined include the coercive force, remanence, shape of the hysteresis loop, Curie temperature, and magnetic moment. Only the Curie temperature was found to be relatively insensitive to neutron irradiation; all the other properties were modified by varying amounts. The radiation sensitivity of metal alloys and selected ferrites appears to be primarily related to the dependence of magnetic properties on the short-range ordering of the atoms along certain crystallographic directions. Materials which can be easily ordered show the greatest sensitivity. It was found that the application of a magnetic field during irradiation can cause directional ordering to take place which in many cases produces more desirable magnetic characteristics. The studies of the ferrites are more complicated since the effects appear to be related to atomic displacements as well as possible radiation induced oxidation. This was deduced from magnetic measurements of irradiated samples coupled with neutron diffraction data of the same material. (auth)

29775 (R56GL23) THE EFFECTS OF NUCLEAR RADIATION ON MISSILE-BORNE SILICON TRANSISTORS, THEORETICAL CONSIDERATIONS. W. R. Langdon, E. L. Mincher, and R. H. Vought (General Electric Co. General Engineering Lab., Schenectady, N. Y.). Jan. 25, 1956. 39p.

The effects of nuclear radiations on silicon transistors were estimated by simplified calculations. These radiations were assumed to come from nuclear explosions, fissionable materials, and cosmic rays. It was concluded that cosmic rays, radiation from fissionable materials, and thermal neutrons from a nuclear explosion will have no effect on the transistor. Gamma rays from a nuclear explosion can be expected to produce transient effects in the transistor. Fast neutrons from a nuclear explosion can cause permanent damage through the creation of interstitial-vacancy pairs. (auth)

29776 (TID-7614(p.117-43)) STATUS OF IRRADIATION OF BULK URANIUM CARBIDE. Frank A. Rough (Battelle Memorial Inst., Columbus, Ohio).

A review of information on the effects of irradiation on bulk UC is presented along with an examination of the research programs in this area. Included is a listing of the participating laboratories and summaries of activities for each. (J.R.D.)

29777 THE FAST NEUTRON FLUX RESPONSIBLE FOR CAUSING RADIATION DAMAGE IN MATERIALS. N. N. Ponomarev-Stepnoi. Atomnaya Energ., 11: 184-5 (Aug. 1961). (In Russian)

The radiation damage of structural materials used in reactors is caused primarily by the interaction of these materials with fast neutrons. As the ionizing effects are negligibly small in metals, the property changes are caused by the dislocation of atoms from their normal positions. This is achieved by means of elastic interaction which requires that the energy to be transferred by higher than about 25 ev. As the number of dislocations and thus the defects in the atomic structure depend on the neutron energy, the neutron flux and its energy spectrum must be known. An equation was derived for determining the energy transmitted by the fast neutrons during the slowing-down process,

allowing then to determine the interaction of the fast neutrons with the material. The data obtained are useable for reactor design. (TTT)

29778 EMISSION, ABSORPTION AND REABSORPTION OF γ -QUANTA BY IMPURITY NUCLEI PRESENT IN A SOLID SOLUTION. I. P. Dzyub and A. F. Lubchenko (Inst. of Physics, Academy of Sciences, USSR). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz., 25: 893-900 (July 1961). (In Russian)

It was shown mathematically that at high temperatures the absorption and emission curves for an impurity in solid solution have the form of a Gaussian curve with a superimposed Mössbauer line. On an energy plot the Mössbauer line is to the right of the maximum of the phonon part of the emission spectrum, and to the left of the maximum of the phonon part of the absorption spectrum. With decreasing temperature the phonon part of the spectrum becomes asymmetrical with the emission falling off more rapidly at higher energies than at lower energies from the maximum (with absorption the situation is reversed). It was shown mathematically that the intensity of the Mössbauer line increases exponentially with decreasing temperature for those temperatures at which $\hbar \omega_s(\max) < \theta$, where ω_s refers to the maximum frequency of the system. The temperature shift in the position of the Mössbauer line is determined by a factor $\alpha \approx (10^{-4} \text{ to } 10^{-7} \text{ sec}^{-1} \text{ deg}^{-1}) T$. High frequencies of the lattice emerge as a criterion for the appearance of a Mössbauer line in the spectrum. The position and intensity of the Mössbauer line are discussed in terms of an adiabatic approximation with the evolution of a large amount of heat and of a small amount of heat. The shape of the Mössbauer line can also vary as a function of the position of the impurity nuclei in the solid solution. (TTT)

29779 THE RESONANCE SCATTERING OF γ -QUANTA BY NUCLEI PRESENT IN A SOLID. I. P. Dzyub and A. F. Lubchenko (Inst. of Physics, Academy of Sciences, USSR). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz., 25: 901-8 (July 1961). (In Russian)

Both resonance and also Rayleigh scattering are observed at low temperatures (for example, for tin at 90°K), although the resonance scattering is a number of times greater than the Rayleigh scattering. Thus, not only the resonance emission and absorption (the Mössbauer effect), but also the resonance and Rayleigh scattering of γ -quanta can be used in studying a solid. The character of the resonance scattering is examined mathematically, and the angular distribution of the scattered γ -quanta, the excitation spectrum and the spectrum of the scattered γ -quanta are determined. It is pointed out that it is possible to measure the frequency of the normal oscillations of a scatterer both from the spectrum of the scattered γ -quanta, and also from the intensity of the Mössbauer line. It is shown that the Mössbauer line can occur at angles other than the Bragg angles. In determining the probability of resonance scattering, the general case is considered where there are a number of resonance scattering nuclei in the elementary cell of the scatterer. Summing over the intermediate and final states, and also averaging over the initial states of the lattice are carried out without making any approximations. (TTT)

29780 RADIATION EFFECTS IN POLYSTYRENE. Donald E. Kline (HRB-Singer Research Labs., State College, Penna.). J. Appl. Polymer Sci., 5: 191-4 (Mar.-Apr. 1961).

Amorphous polystyrene was subjected to nuclear radiation in doses ranging from 1.2×10^{10} to 3.8×10^{11} ergs per

gram. At low temperatures the internal friction of the highly irradiated polystyrene was greater than that of the unirradiated material, and beyond the glass transition, which begins near 370°K, the irradiated sample remained a solid and the internal friction decreased. Below 370°K the dynamic modulus of the highly irradiated material scarcely differed from that of the unirradiated sample, while beyond 500°K it was rather high (near 10^5 psi). At low irradiation doses crosslinking occurred sufficient for the information of nonliquefying, three-dimensional network in the polystyrene, but no changes in the dynamic mechanical properties attributable to irradiation were detected. (auth)

29781 THE TENSILE PROPERTIES OF HEAVILY DEFORMED MOLYBDENUM AFTER NEUTRON IRRADIATION. D. N. Sethna, A. A. Johnson, K. J. Proud, and S. S. Sheinin (Royal School of Mines, London). *J. Inst. Metals*, 89: 476-9 (Aug. 1961).

The ductile-brittle transition temperature of heavily swaged molybdenum of commercial purity was measured before and after irradiation to doses of up to 4×10^{19} nvt. The tests were carried out in a tensometer at a strain rate of 0.88×10^{-4} sec⁻¹, and the transition temperature was taken to be the highest temperature at which no appreciable plastic strain occurred before fracture. The transition tem-

perature both before and after irradiation was found to be $-110 \pm 10^\circ\text{C}$. (auth)

29782 METALLURGY IN NUCLEAR POWER TECHNOLOGY. 4. BEHAVIOUR OF FISSILE METALS UNDER IRRADIATION. J. C. Wright (Coll. of Advanced Tech., Birmingham, Eng.). *Metal Treatment and Drop Forging*, 27: 427-32; 426 (Oct. 1960).

Radiation effects on plutonium and uranium metals and alloys are described. Some of the problems discussed are wrinkling; radiation growth, absorption, scattering, hardness; and annealing of radiation damage. The theory of radiation growth is also discussed. (N.W.R.)

29783 INFLUENCE OF NEUTRON IRRADIATION ON PHASE TRANSFORMATION IN CHROMIUM STEELS. B. Weiss-Hollerwoger and R. Mitsche. *Radex Rundschau*, 318-22 (Dec. 1960).

Austenite-martensite transformation curves are established between -200 and 800°C for austenitic 5.4% Cr steel after exposure to 0 to 10^{18} n/cm² neutron irradiation at 25°C. Measurement of the amount of martensite is accomplished by permeability and hardness measurements. The influence of irradiation on martensite temperature is shown. Results are interpreted by strain-embryo theory. (TCO)

PHYSICS

General and Miscellaneous

29784 (AD-250884) HYDRODYNAMICAL TREATMENT OF ELECTRON FLOW. Annual Technical Report No. 2, Covering December 1, 1959 to November 30, 1960. H. Pötzl, K. Richter, and K. Tögel (Vienna. Technische Hochschule. Institut für Hochfrequenztechnik). Jan. 31, 1961. Contract DA-91-591-EUC-1312. 82p.

The admittance of a diode is found for extremely high and extremely low frequencies at the non-space-charge-limited (exponential) operating region. The admittance is found by solving the Boltzmann equation for these frequencies. The admittance for arbitrary frequencies is found by combining the high- and low-frequency equivalent circuits. An isothermal theory is used to find the admittance in the space-charge-limited region of operation. This isothermal approach yields inaccurate results in the exponential region. (T.F.H.)

29785 (AFOSR-1264) BASIC STUDY OF ENERGY EXCHANGE PROCESS BETWEEN AN ELECTRIC ARC AND A GAS FLOW. Final Report, March 1, 1958 through January 31, 1961. Paul G. Thieme (Plasmadyne Corp., Santa Ana, Calif.). Feb. 23, 1961. Contract AF49(638)334. 15p.

Studies were carried out relating to the interaction of an electric discharge and a gas flow. The stabilization of a spark by a gas vortex during the initial phase of the electrical breakdown was demonstrated photographically. The radial pressure distribution in the vortex was investigated. A plasma-flow facility is described which was developed to combine the steady-state flow characteristics of a wind tunnel with the high gas-temperature capabilities of a shock tube. The average electrical conductivity of the plasma over a cross section of the tube was measured. A theoretical investigation was conducted of the flexure of an arc positive column. A subsonic wind tunnel was especially devised to provide a uniform, reproducible laminar flow for studying the convective deflection of an arc column. (M.C.G.)

29786 (AFOSR-1331) THEORY OF SPIN WAVE INTERACTIONS IN FERROMAGNETISM. Technical Report No. 222. Newton Isaac Greenberg (Maryland. Univ., College Park). July 1961. Contract AF49(638)-399. 149p.

The interactions of spin waves in an ideal Heisenberg model of a ferromagnet are studied, for which the effects on the free energy and spontaneous magnetization are examined. Treating a spin wave as a local phenomena, only binary collisions between spin waves need be considered at low temperature. The free energy of the system is developed as an expansion in terms of a binary kernel function; this binary kernel function is determined from the two particle propagator, which can formally be evaluated. When the free energy expansion is evaluated, the results of Dyson are obtained. That is, the lowest order correction term introduced in the spontaneous magnetization by spin-wave interactions is of the order T^4 . (auth)

29787 (AFOSR-1381) THE INTERACTION BETWEEN A MAGNETIC FIELD AND AN ELECTRICALLY PRODUCED SHOCK WAVE. John Paul Barach (Maryland. Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). July 1961. Contract AF49(638)-401. 64p. (BN-255)

Shock wave flows of speeds to 1 cm/ μ sec were observed

to interact with a magnetic field of 5700 gauss. A reflected shock is observed and the deceleration of the flow is measured. Gas flows to Mach 63 in krypton are produced by an annular electric shock tube powered by a discharge of long time constant. A radial magnetic field provides closed paths within the gas flow for the induced currents. The speed of the wave reflected off the magnetic field is found to increase with interaction strength. The flow momentum lost per particle as the flow traverses the field region, is calculated and compared to the impulse delivered each particle by the magnetic field. Agreement is found over a wide range of experimental conditions, validating the magnetohydrodynamic picture of the interaction and the use of the scalar gas conductivity. (auth)

29788 (ANL-4983(Del.)) PHYSICS DIVISION, SUPPLEMENT TO THE SUMMARY REPORT, JUNE THROUGH NOVEMBER 1952. (Argonne National Lab., Ill.). Mar. 1953. Decl. with deletions Feb. 23, 1960. Contract W-31-109-eng-38. 29p.

Transmission measurements with the fast chopper were made on U^{233} , normal U, and Pu. A search was made for Pu^{244} . The crystal structures of $Mg(UO_2)_2O_2$ and KU_2F_9 were investigated. The magnitude of the resonance flux in CP-3' was measured. Multigroup methods for concentrated fast assemblies were studied. Work on the ZPR-II Reactor was continued. (M.C.G.)

29789 (ANL-6310) A THEORETICAL STUDY OF SIMPLE MANY-ELECTRON SYSTEMS. Lester M. Sachs (Argonne National Lab., Ill.). May 1961. Contract W-31-109-eng-38. 243p.

A study was made of the one-electron approximation for a number of simple many-electron systems. A review is given of the mathematical structure underlying the Hartree-Fock (HF), Unrestricted Hartree-Fock (UHF), and Projected Unrestricted Hartree-Fock (PUHF) approximations which may be utilized to obtain approximate solutions of the many-electron Schrödinger equation. The salient features of each method and their applicability to simple systems are outlined. Solutions using the above approximations were obtained by the "self-consistent field" (SCF) method utilizing a finite set of Slater-type functions as an expansion set. This becomes a matrix procedure and involves the calculations of the matrix elements of the operators and the solution of the matrix (operator) equations. To this end, a number of computer programs were written for the IBM-704 digital computer and utilized to obtain the desired solutions. Hartree-Fock solutions were obtained for the atomic configurations $1s^2$, $1s^22s$, and $1s^22s^2$ for the range of atomic number $2 \leq Z \leq 10$. The UHF solution of lithium was also obtained and the PUHF solution projected from it. A tabulation of the orbitals and two measures of their quality is given for all SCF solutions. Utilizing the HF, UHF, and PUHF solutions, the hyperfine splitting of the lithium ground state is calculated by first-order perturbation and found to be given best by the UHF method, approaching the experimental value. The diamagnetic susceptibilities of He, Li^+ , Li^- , and Be were calculated. Hartree-Fock solutions were also obtained for the ground states of F, F^- , Ne, Na^+ , and Na, and for Na^+ and F^- in the presence of superposed charged spheres. A tabulation of the orbitals and their goodness is given for this series. The diamagnetic susceptibilities of the ten-electron systems were calculated. The doublet separation of the fluo-

rine ground states was computed, and the hyperfine splitting of sodium and fluorine was obtained. A number of recommendations are offered regarding the SCF computational procedure. (auth)

29790 (ANL-6390) THERMODYNAMICS AND STATISTICAL MECHANICS OF A THREE-LEVEL MASER. William A. Barker (Argonne National Lab., Ill.). July 1961. Contract W-31-109-eng-38. 25p.

The population distribution and the associated thermodynamic properties of a three-level maser are calculated. By treating the three spin states as individual chemical species, it is possible to write the partition function, free energy, internal energy, entropy, and chemical potential for each species. The principle of minimum entropy production is used to derive an equation of reaction equilibrium. This equation is used in separate thermodynamic and statistical mechanical calculations to obtain the normalized population distribution. This result agrees in first order with that obtained by means of the rate equations. Competitive relaxation processes and partial saturation effects are discussed. The saturation parameter used is the one defined in the treatment of the Overhauser effect. An explicit expression is obtained for this parameter in terms of the various transition probabilities, and its effect on maser performance is discussed. (auth)

29791 (HW-68389) PHYSICS RESEARCH QUARTERLY REPORT, OCTOBER, NOVEMBER, DECEMBER 1960. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 20, 1961. Contract AT(45-1)-1350. 81p.

Theoretical and experimental investigations of reactor physics are reported. The few-group equations are derived under the assumptions of overlapping group spectra, arbitrary kernel, and energy-dependent diffusion coefficients. The two-group equations are derived for a system with temperature discontinuities, using infinite medium spectra as trial spectra. An improvement in the multi-group neutron diffusion code HFN is developed, in order to eliminate round-off errors. The Gauss-Seidel iterative method is applied to homogeneous systems of equations, in a search for a way to speed convergence of multigroup equations. The rethermalization of neutrons, caused by temperature discontinuities, is analyzed in graphite and water. The resonance integrals and Cd ratios of natural Cu, Cu^{63} , and Cu^{65} are measured. The total temperature coefficient of reactivity of the Physical Constants Testing Reactor is measured from 24 to 31°C. The lattice parameters are measured for a 2.5 in. natural U fuel element in a water- or air-cooled graphite lattice. (T.F.H.)

29792 (IS-131) A TEST FOR ELECTRON TRANSFER IN THE INTERMETALLIC COMPOUND, V_4Al_{23} . Alden Earl Ray and J. F. Smith (Ames Lab., Ames, Iowa). Aug. 1959. Contract W-7405-eng-82. 45p.

X-ray diffraction techniques were used to test for spatial transfer of electrons in the intermetallic compound, V_4Al_{23} . Three dimensional intensity data were collected from a spherical crystal of V_4Al_{23} by the moving-crystal stationary-counter technique. These data were corrected for the effects of absorption, dispersion, secondary extinction, and anisotropic thermal motion of the atoms. Reflections for which $\sin \theta/\lambda > 0.29\text{\AA}^{-1}$ should be insensitive and reflections for which $\sin \theta/\lambda < 0.29\text{\AA}^{-1}$ should be sensitive to the distribution of the outer electrons were found. The interpretation is that all of the Al atoms and six of the eight V atoms in the structure contribute approximately equal numbers of electrons to participate in the bonding,

while the remaining two V atoms contribute a smaller number of bonding electrons. (J.R.D.)

29793 (IS-336) MICROWAVE MEASUREMENTS OF HALL MOBILITIES IN SEMICONDUCTORS. Yuichiro Nishina and G. C. Danielson (Ames Lab., Ames, Iowa). Nov. 1960. Contract W-7405-eng-82. 101p.

The Hall mobilities of germanium single crystals were measured with a microwave frequency of 9000 Mc/sec over the temperature range 30 to 300°K. A rectangular sample occupied the central part of a wall of a rectangular cavity, which was doubly degenerate in the TE_{101} mode and in the TE_{011} mode at a single resonance microwave frequency. The external magnetic field and the microwave field associated with one of the two modes gave rise to the other mode of oscillation, owing to excitation by the microwave Hall field. The theoretical analysis was verified by measurements on an n-type sample having a room temperature resistivity of 0.40 ohm cm. The measured Hall mobility at microwave frequencies (with a size correction) was compared with the d-c Hall mobility between 30 and 300°K. The maximum discrepancy was 15%. The estimated experimental error in the microwave measurement was 16%. The magnetic field dependence of the microwave Hall mobility in a p-type sample, having a room temperature resistivity of 0.77 ohm cm, was in qualitative agreement with the d-c results. (auth)

29794 (MRL-100) COMPTON INCOHERENT SCATTERING FUNCTIONS FOR IONS OF THE FIRST TRANSITION SERIES. A. J. Freeman and R. E. Watson (Watertown Arsenal. Materials Research Lab., Mass. and Avco Mfg. Corp. Research and Advanced Development Div., Wilmington, Mass.). Aug. 1961. 19p.

Compton incoherent scattering functions are found for the transition elements Sc through Cu using the complete Waller-Hartree theory including the effects of the non-sphericity of the charge distributions. These calculations are extensions of analytic Hartree-Fock wave functions determined by considering only $3d^n$ configurations. Results are given for three states of ionization (+1, +2, and +3) for each of the elements; the configurations $3d^n$ differ from the ground state only for the +1 ions other than Cr and Cu. The role of the 4s electrons is discussed. (auth)

29795 (NASA-TN-D-413) ROCKET MEASUREMENT OF A DAYTIME ELECTRON DENSITY PROFILE UP TO 620 KILOMETERS. J. E. Jackson and S. J. Bauer (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). Sept. 1961. 8p.

On April 27, 1961, at 1502 EST a four-stage research rocket was fired from Wallops Island, Virginia, to measure the ionospheric electron density distribution by means of Seddon's CW propagation technique. This experimental technique is based upon the dispersive Doppler effect measured at two harmonically related frequencies, in this case $f = 12.267$ Mc and $6f = 73.6$ Mc. The electron density profile measured above the peak of the F2 region is representative of a diffusion-equilibrium distribution in an isothermal ionosphere having a temperature of $1640^\circ \pm 90^\circ\text{K}$. This result, when compared with satellite and other data, indicates that the upper ionosphere is in thermodynamic equilibrium. (auth)

29796 (NP-10646) PROCEEDINGS OF FIRST NATIONAL CONFERENCE ON THE PEACEFUL USES OF SPACE, TULSA, OKLAHOMA, MAY 26-27, 1961. (National Aeronautics and Space Administration, Washington, D. C.). 188p.

Discussions are presented covering communications,

weather, and navigation satellites; space probes; space research; nuclear propulsion for spacecraft; life sciences programs; and launch-vehicle programs. Educational and personnel requirements for the space age are outlined. Manned space flight studies include: the X-15 and Dyna Soar maneuverable vehicles; the Mercury and Apollo vehicles; physiological problems; future missions; and launch-vehicle considerations. (T.F.H.)

29797 (NP-10654) NRL QUARTERLY ON NUCLEAR SCIENCE AND TECHNOLOGY PROGRESS REPORT FOR THE PERIOD APRIL-JUNE 1961. (Naval Research Lab., Washington, D. C.). July 1, 1961. 23p.

Research progress in nuclear science and technology is reported. The $O^{18}(p,n)F^{18}$ threshold energy was measured using the 5-Mev Van de Graaff as a source of protons and the 2-m electrostatic analyzer for absolute calibration of the proton energy. The differential cross sections for the ground state and first excited state alpha particles from the $Li^7(t,\alpha)He^6$ reactions were measured as functions of the angle of emission and the bombarding energy. The differential cross sections for the $Li^6(t,d)Li^7$ and $B^{10}(t,d)B^{11}$ reactions were studied. The cross sections for the $C^{12}(t,\alpha)B^{11}$ reactions leaving B^{11} in the ground state and first excited state were determined. Angular correlations in the reaction $B^{10}(He^3,p\gamma)C^{12}$ were investigated. The angular correlations between the first excited state alpha particles from the $C^{13}(He^3,\alpha\gamma)$ reaction and the subsequent 4.43-Mev gamma rays were studied as functions of the angles of emission. The cluster model expansion of nuclear wave functions is described. A selective signal detector was developed for measuring low-level, radioactive, airborne contamination. This continuous monitor is capable of detecting 10^{-11} $\mu\text{c/cc}$ in a radon background of 10^{-10} $\mu\text{c/cc}$. (M.C.G.)

29798 (NP-10667) STUDY OF NUTATIONAL RESONANCE IN OPTICALLY PUMPED RUBIDIUM VAPOR. Final Report, August 1, 1959 to August 31, 1961. Wolfgang Franzen (Little (Arthur D.) Inc., Cambridge, Mass.). Aug. 21, 1961. Contract Nonr-2962(00). 80p. (ALI-C-62344)

A method for the optical observation of nutational resonance in optically pumped rubidium vapor is studied both experimentally and theoretically. The method consists of pulse-modulating a r-f magnetic field at one of the Zeeman resonance frequencies of the vapor and observing the resulting damped transient modulation in the transmitted light intensity. Of particular interest is the application of this method to a study of the spin relaxation of vapor atoms as influenced by the physical parameters of the system, in the case where the applied steady magnetic field is intense enough to cause individual Zeeman intervals to become noticeably unequal. Both single and double quantum resonances at a wide spectrum of Zeeman transitions of Rb^{85} vapor diffusing through neon and helium buffer gases are observed and identified, and the damping of the transient nutations in light intensity is recorded under a variety of conditions. (auth)

29799 (NP-10689) THE INFRARED SPECTRA AND STRUCTURES OF THE CRYSTALLINE PHASES OF CH_4 AND CD_4 . Technical Report No. 10. George B. Savitsky and D. F. Hornig (Princeton Univ., N. J. Frick Chemical Lab.). Aug. 15, 1961. Contract Nonr-1858(27). 27p.

Infrared spectra of CH_4 and CD_4 , in the region of the fundamentals ν_3 and ν_4 , were obtained in all of their crystalline phases at temperatures ranging from 5 to 40°K. In addition, the spectra of dilute solutions of CH_4 and CD_4 in

one another were studied through the same temperature range. The spectra of the dilute solutions consist of single sharp lines for both fundamentals, demonstrating that the barriers to molecular rotation are high in all the phases. The fine structure observed in the low temperature phases of the pure crystals is inconsistent with any of the structural models heretofore proposed but two models for phase II are suggested which are consistent with the spectra and which show efficient packing. Phase III of CD_4 is probably complex and of low symmetry. Phase I is probably disordered. (auth)

29800 (NP-10690) BACKGROUND INTENSITIES IN SINGLE CRYSTAL DIFFRACTOMETRY. Technical Report No. 2. R. A. Young (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). July 27, 1961. Contracts NONr 991(00) and 991(06); NR 017-623. 95p.

The question of the component parts and character of the background in x-ray diffraction was re-examined in some detail. The components were divided into two classes: those which may be peaked at the Bragg position, principally the harmonic components; and those which do not peak at the Bragg position, here called the miscellaneous components. The contribution to apparent Bragg intensities of harmonic and even sub-harmonic wavelengths in crystal-monochromatized incident radiation is generally recognized. However, in current practice at least, the fact appears usually to be overlooked that harmonic wavelengths contribute to the observed intensity at the Bragg setting even in the ordinary, filtered-radiation techniques. Neglect of this contribution would have produced an intensity error larger than a factor of two in one example. The ω -scan and peak-height methods of single crystal diffractometry were particularly affected. Pulse height discrimination alone was inadequate to correct the problem; it appeared necessary to use balanced filters and to make measurements both on and off the Bragg setting. The common method of taking as the whole background the intensity obtained by off-setting the crystal alone completely misses these harmonic contributions. An expression is presented for the dependence of the harmonic contributions on counter aperture, structure factors, Bragg angle, temperature, and other parameters. The qualitative correctness of the expression was demonstrated by experimental results. The consequences of neglecting this component are discussed in several connections and are demonstrated in some. The control and measurement of the miscellaneous component was also considered. Particular attention should be given to the counter aperture size and to both incident and receiving collimators even with the large beam used in single crystal diffractometry. The circumstances under which each scanning method may be used were examined. It was concluded that the peak height method is inherently a poor method. It was recommended that a balanced filter technique be used with the ω -scan at all times and in some cases with the 2θ -scan. The ω -scan was then slightly preferable for other reasons. Detailed procedures for correct background determination with balanced filters are presented. Implications to film methods and to powder diffractometry are also pointed out. It was concluded that background measurements are best made on the Laue streaks and that all strong reflections should be made to appear on zero layer photographs where the full extent of these Laue streaks may be seen. (auth)

29801 (NP-10695) EMISSIVITY. An Annotated Bibliography. A. A. Beltran, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). July 1961. Contract AF04(647)-787. 155p. (SB-61-38)

References on the emissivity of materials in the infrared, visible, and ultraviolet spectrum at temperatures to 3300°K are given to books and reports and U. S. and foreign journals and theses published from 1905 through 1961. The arrangement is alphabetical by author, and an extensive subject index is included. (322 references.) (P.C.H.)

29802 (NP-10705) ASTRONAUTICS INFORMATION, ABSTRACTS, VOLUME IV, NUMBER 2, ABSTRACTS 4,101-4,201. B. J. Hardgrove, E. H. Sands, and F. L. Warren (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Aug. 1961. Contract NASw-6. 43p.

A bibliography is presented consisting of 101 annotated references relating to space flight and to applicable data and techniques, which covers the period for Aug. 1961. (B.O.G.)

29803 (NYO-9583) APPLICATIONS OF ULTRASONIC ENERGY. TASK 2: ULTRASONIC METAL AND CERAMIC POWDER PROCESSING. TASK 3: ULTRASONIC INSTRUMENTATION. Progress Report No. 27, Covering Period from April 1, 1961 to May 31, 1961. (Aeroprojects, Inc., West Chester, Penna.). June 1961. Contract AT(30-1)-1836. 35p.

Ultrasonically activated plate molds (24 in. \times 1 in. \times 0.060 in.) were completely filled with cermet (Al_2O_3 -Stainless Steel) slips; nonultrasonic control tests resulted in molds approximately $\frac{1}{3}$ filled, and the specimens so prepared were hollow. Ceramic slips (Al_2O_3) completely filled the plate mold under ultrasonic activation; nonultrasonic control tests led to incomplete mold filling. A series of cylindrical specimens is being prepared using the cermet formulation to determine the effect of ultrasonic activation on the physical properties. Green densities were significantly improved by ultrasonics. Ultrasonic filling of long stainless steel tubes with arc-fused, ground, and sized ThO_2 - UO_2 resulted in 9.22-g/cc (91.8% of theoretical density) compacts as compared to 8.9-g/cc (88.7% of theoretical density) obtained with conventional vibratory compaction. Ultrasonic activation of a modified ball tableting punch produced alumina pellets with green densities in excess of 82% of theoretical. No static compressional force was used, other than that of the transducer assembly. Fracture of the green pellets, "capping," during release from the punch-and-die set, was virtually eliminated through ultrasonic treatment, indicative of more uniform powder flow during forming. The application of ultrasonic standing-wave-ratio instrumentation to the detection of foam level, a problem in boiling water reactors, showed adequate sensitivity. Tests are reported in both stabilized simulant foam and steam-generated foam. The problem of measuring changes in particle size and concentration in particle/gas heat exchange loops was analyzed and an experimental program initiated. Two approaches, resonant column techniques and vibratory ribbon interaction, presently appear promising. Ultrasonic cavitation threshold detection, of use in estimating localized incipient boiling, appeared to have adequate sensitivity to be used with wire-like sensing elements. (auth)

29804 (ORO-447) ON THE TRAPPING OF CHARGED PARTICLES BY MAGNETIC FIELDS. Technical Report No. 2. B. N. A. Lamborn and D. L. Lafferty (Florida. Univ., Gainesville). July 5, 1961. Contract AT(40-1)-2783. 14p.

The behavior of a charged particle in a magnetic field $\vec{B} = \hat{z}B_0$ (r/r_0)² is investigated. Particles that are injected perpendicular to \vec{r} and \vec{z} , with an angular velocity different from that corresponding to a circular orbit at the injection radius, attain a purely radial motion at some

radius when $n \leq -1$. It is suggested that for many particles, the behavior near this radius is approximately that of two colliding particle streams. The energy losses caused by the associated stream instabilities may serve as a mechanism for trapping particles in the magnetic field configuration. (auth)

29805 (RM-2807-PR) A PARAMETRIC STUDY OF CERTAIN LOW-MOLECULAR-WEIGHT COMPOUNDS AS NUCLEAR ROCKET PROPELLANTS. V. METHANE. F. J. Krieger (RAND Corp., Santa Monica, Calif.). Aug. 1961. Contract AF49(638)-700. 71p.

A parametric investigation was made of a series of low-molecular-weight, high-hydrogen-content compounds as propellants for nuclear-powered rockets. The chemical compounds include H_2 , NH_3 , H_2O , LiH , CH_4 , and CH_3OH . A two-part computational program was carried out for each compound; the results for methane are presented in both tabular and graphic form. The results of the first part of the program are presented in static form, that is, by the conventional Mollier diagram, in which specific enthalpy is plotted against specific entropy, with cross plots of temperature, pressure, and molecular weight. The results of the second part of the program are presented in dynamic form by a series of diagrams in which specific impulse is plotted against pressure, with cross plots of chamber temperature, exhaust temperature, and rocket-nozzle area. It was assumed that the propellant gas, starting with a nonzero chamber velocity, maintained instantaneous chemical equilibrium composition as it expanded isentropically through a de Laval nozzle. (auth)

29806 (UCID-4344) THEORY OF UNDERGROUND EXPLOSIONS. John Nuckolls (California. Univ., Livermore. Lawrence Radiation Lab.). Apr. 27, 1960. 15p.

A qualitative description of the theory of underground explosions as applied to the Cowboy Project is presented. The theory is an approximate steady-state analysis of the cracked-elastoplastic-hydrodynamic model used in the Underground Nuclear Explosion Code. This model differs from the elasto-hydrodynamic model presented previously in that the material between the elastic and plastic regions is treated as an elastic solid with radial cracks rather than as a fluid. A critical analysis of the theory is included. (M.C.G.)

29807 (UCRL-6514) GETTERS OF GASES. A BIBLIOGRAPHY. Carl J. Wensrich (California. Univ., Livermore. Lawrence Radiation Lab.). July 1961. Contract W-7405-eng-48. 12p.

A selective bibliography is given which contains 110 papers on the getters of gases covering the period from 1930 to 1960. The following sources were consulted: Chemical Abstracts, Physics Abstracts, and Nuclear Science Abstracts. The list is arranged alphabetically by author. (M.C.G.)

29808 (AEC-tr-4635) THE CRYSTALLIZATION OF A SUPERCOOLED LIQUID IN AN ULTRASONIC FIELD. L. O. Maleshko. Translated from *Inzhener.-Fiz. Zhur.*, Akad. Nauk Belorus. S.S.R., 4: 123-5 (1961). 6p.

The effect of an ultrasonic field on the crystallization of supercooled naphthalol or betol (2-naphthyl salicylate) was investigated. It was established that under the influence of ultrasonic phenomena in a supercooled melt, mass generation of nuclei of the new phase occurs near the faces of the growing crystals. This was due to the dispersing action of the field. It was found that under the influence of ultrasonic waves the temperature curve of the number of nuclei of crystallization shifts toward the lower temperatures. (auth)

29809 (AEC-tr-4789) INFRARED SPECTRA AND THE THERMODYNAMIC PROPERTIES OF WATER ADSORBED ON A HYDRATED SILICA SURFACE. A. V. Kiselev (Kiseliev) and V. I. Lygin. Translated for Oak Ridge National Lab. from *Kolloid. Zhur.*, 23: No. 2, 157-62(1961). 8p.

Methods of calculating the entropy of water adsorbed on a hydrated silica surface using certain adsorption complex models and the molecular vibrational frequencies manifested in them in the infrared spectrum are discussed. The sums of the vibration, rotation, and combination entropies, estimated by the method, are approximately 4 to 7 eu. Experimental and theoretical methods necessary to develop and perfect the statistical thermodynamic treatment of adsorption complexes are discussed. (N.W.R.)

29810 (AEC-tr-4790) BEAMS FROM CONDENSED ATOMS AND MOLECULES IN A HIGH VACUUM. E. W. Becker, K. Bier, and W. Henkes. Translated for Oak Ridge National Lab. from *Z. Physik*, 146: 333-8(1956). 15p. (Includes original, 6p.).

This paper was previously abstracted from French and appears in *NSA*, Vol. 15, abstract no. 3229.

29811 (AEC-tr-4792) VELOCITY ANALYSIS OF LAVAL BEAMS. E. W. Becker and W. Henkes. Translated for Oak Ridge National Lab. from *Z. Physik*, 146: 320-32(1956). 29p. (Includes original, 10p.).

Measurement of the velocity of Laval beams by means of the time-of-flight method is described. It results in an oscillogram in which the influence of the experimental parameters can be directly observed. (J.R.D.)

29812 (AEC-tr-4804) CONCERNING THE GLOWING OF CERTAIN METAL OXIDES. J. Bohm. Translated by Gordon Love for Carnegie Inst. of Tech., Pittsburgh from *Z. anorg. u. allgem. Chem.*, 149: 217-22(1925). 8p.

The phenomenon of a metal oxide glowing upon being heated to a certain temperature is discussed. The prerequisites for the occurrence of glowing are large heat evolution during crystallization, high crystallization rate, and an amorphous-to-crystalline transformation. X-ray studies of the structures of various metal oxides confirm that the glowing phenomenon is due to a sudden crystallization in an amorphous material. (D.L.C.)

29813 (JPRS-9934) SELECTED TRANSLATIONS FROM WU LI HSUEH PAO (ACTA PHYSICA SINICA), 15: NO. 4-5, 178-85; 210-16; 230-45; 262-8(APR.-MAY 1959). 75p.

Translations of four papers from WU-Li Hsueh-Pao (*Acta Physica Sinica*) of April and May 1959 are presented. Topics covered include: the slope of the calibration curve in spectrochemical analysis, radial distribution of the elemental quantities of thermally excited spectral lines in the equi-ion zone of a d-c electric arc, Λ° and θ° particles produced in Pb and Al, and the radiative capture of μ mesons by protons. A separate abstract was prepared for one paper. One paper was previously abstracted in *NSA*. (M.C.G.)

29814 (NP-tr-732) STUDY OF THE DOSE RATE FIELD OF A CYLINDER EMITTER WITH A HIGH-POWER SOURCE OF Co^{60} γ -RADIATION. A. Kh. Breger, M. A. Dembrovskii (Dembrovskiy), L. A. Dmitriev (Dmitriyev), L. L. Sunitsa, and Yu. S. Ryabukhin. Translated from *Problemy Fiz. Khim.*, 2: 132-45(1959). 28p.

An experimental and theoretical study was carried out on the dose rate field of the irradiation from a gamma source of Co^{60} with an activity of 20,600 g-eq of radium,

which creates a maximum dose rate of ~ 1000 r/sec. It was found that for gamma radiation of Co^{60} , the dosimetric reaction yields for the oxidation of iron and the reduction of cerium remain constant up to irradiation dose rates of 1000 r/sec. A calculation of the irradiation dose field for a hollow cylinder source of gamma radiation showed that the divergence in the results obtained from the formulas for a hollow cylinder of finite dimensions and for an infinitely thin cylinder does not exceed 1.5% for the working region of the emitter. It was found that the difference of the effective activity of the source for the internal and external region of the emitter is produced by the effect which the screening of some portions of the emitter by others has on the dose field in the external region. (M.C.G.)

29815 CONSERVATION LAWS AND FERN-EQUIVALENCE IN GENERAL RELATIVITY. Jerzy Rayski (Jagellonian Univ., Krakow). *Acta Phys. Polon.*, 20: 509-15(1961). (In English)

A generalized parallelism (called fern-equivalence), fern-equivalent tetrads, and quasi-cartesian coordinates are defined in riemannian geometry with the help of one-parametric families of extremal (minimal) hypersurfaces. The same ideas are applied to secure conservation laws and localization of energy, momentum, and angular momentum in general relativity. (auth)

29816 THE GENERALIZATION OF DIRAC'S EQUATION. [PART] II. Jerzy Lukierski (Univ. of Wroclaw, Poland). *Acta Phys. Polon.*, 20: 517-35(1961). (In English)

The quantized Lagrangian formalism, which leads to the generalized Dirac equation is investigated. The theory is invariant with respect to the 12-parameter $C \times C'$ group. The Lagrangian is described by means of the two real isovectors: the mass-isovector χ_μ and a second isovector δ'_μ not occurring in the equation. The isovector δ'_μ is necessary for quantization invariant under $C \times C'$. It is shown that the Jauch field may be obtained and generalized after a special choice of δ'_μ . (auth)

29817 SORPTION AND REPLACEMENT OF IONIZED NOBLE GASES AT A TUNGSTEN SURFACE. R. B. Burt, J. S. Colligon, and J. H. Leck (Univ. of Liverpool). *Brit. J. Appl. Phys.*, 12: 396-400(Aug. 1961).

Ion beams of the order of five micro-amperes with a low energy spread were used to bombard a tungsten surface. Sorption values for the surface are given for neon, argon, and krypton and show that a maximum sorption exists at any particular bombarding ion energy. A value for the depth of penetration of the ions is derived from the results and this is shown to be in reasonable agreement with values quoted by other workers. Results from a second series of experiments where ions of a second gas release the sorbed ions of the first gas are also presented. (auth)

29818 ABSORPTION AND LUMINESCENCE IN IMPURITY-ACTIVATED ALKALI HALIDES. R. A. Eppler (Corning Glass Works, Corning, N. Y.). *Chem. Revs.*, 61: 523-35(Oct. 1961).

A survey of the theoretical and experimental literature on the absorption and luminescence in lead or thallium activated alkali halides is given, and an over-all view is summarized. 161 references are given to books, conference papers, and U.S. and foreign journals published from 1907 to 1960. (P.C.H.)

29819 ELECTRICAL CONDUCTIVITY OF THE CONSTITUENTS OF AIR UNDER THE ACTION OF A SHOCK

WAVE. Jacques Thouvenin, Roger Simonet. *Compt. rend.*, 252: 243-5 (Jan. 9, 1961). (CEA-1957). (In French)

Electrical conductivities of oxygen and nitrogen under the action of a shock wave are compared with those of air. The results confirm the hypothesis already put forward on the part played by NO. (auth)

29820 FLUCTUATION OF THE ELECTRON DENSITY IN THE IONOSPHERE. E. A. Novikov (Inst. of Atmospheric Physics, Academy of Sciences, USSR). *Doklady Akad. Nauk S.S.S.R.*, 139: 587-9 (July 21, 1961). (In Russian)

The turbulent fluctuation of the electron density was examined at a height of 110 km where the collision frequency of ions is higher than their Larmor precession frequency in the magnetic field of the Earth. The previously accepted conclusion that the locally isotropic turbulence does not result in an anisotropic fluctuation in spite of the role played by the magnetic field in the generation of fluctuations, is held to be incorrect. Two excitation mechanisms of the electron density fluctuation are distinguished, —one being dependent on the vertical average electron density gradient and on the turbulent mixing beyond this gradient, —the other resulting from action of the magnetic field of the Earth. Under conditions of local isotropy of the turbulent field a relation was derived from the fluctuation equations between three dimensional spectral function of the fluctuation and the spectral density of the kinetic energy. It is shown that the electron density changes only slightly in the direction of the field and strongly in a direction vertical to it, indicating the presence of inhomogeneities. Below 65 km the anisotropic fluctuations are placed crosswise under an angle of 45°. However, in view of their small amplitudes, anisotropic fluctuations are difficult to observe at such heights. (TTT)

29821 ONE-DIMENSIONAL ADIABATIC FLOW OF ULTRARELATIVISTIC GAS. K. P. Stanyukovich (Moscow State Univ.). *Doklady Akad. Nauk S.S.S.R.*, 139: 590-3 (July 21, 1961). (In Russian)

Equations have been derived for cases of ultrarelativistic gas flow, making it possible to solve propagation problems of simple and of reflected waves. A similar solution was arrived at in Euler coordinates by I. M. Khalatnikov (Zhur. Eksptl'. i Teoret. Fiz. 27: 11 (1954) No. 5); however, the assumptions prevented generalization of the solution. It was assumed that the ultrarelativistic gas is completely identical with a photon medium, the thermodynamical potential of which is 0. But electron and neutron ultrarelativistic media have a potential other than 0; accordingly Khalatnikov's equations apply only to isentropic motion and not for adiabatic conditions and for shock waves. (TTT)

29822 SOME EFFECTS OF TENSOR CONDUCTIVITY IN MAGNETOHYDRODYNAMICS. B. Sonnerup (Cornell Univ., Ithaca, N. Y.). *J. Aero/Space Sci.*, 28: 612-21; 643-4 (Aug. 1961).

A theoretical investigation concerning some Hall-current effects in inviscid, incompressible magnetohydrodynamics is made. The generalized Ohm's law and the concept of tensor conductivity are discussed. The macroscopic equations governing steady small-perturbation flow of a fully ionized gas are developed for three orientations of an applied magnetic field of infinite extent. These equations are then solved for flow past an insulating sinusoidal wall. The general solutions, pertaining to arbitrary values of magnetic Reynolds number and Hall parameter, are studied in the limits of large and small magnetic Reynolds number, and characteristic Hall-current loops are detected. The

pressure distribution on the wavy wall is investigated as a function of magnetic Reynolds number and Hall parameter. For the particular cases investigated the influence of non-scalar conductivity is much smaller than elementary considerations would indicate. The classical plane Alfvén wave is modified to have a slowly rotating plane of polarization in some analogy with the behavior of a plane-polarized light beam in an optically active medium. The modified Alfvén wave is used to explain certain features of the wavy-wall solution for large magnetic Reynolds number and an applied magnetic field perpendicular to the plane of the wall. (auth)

29823 TAIT COEFFICIENTS AND A TRANSITION OF HELIUM I AND II. Robert Ginell (Univ. of Utah, Salt Lake City). *J. Chem. Phys.*, 35: 473-8 (Aug. 1961).

Helium I and helium II are both found to obey Tait's law. The constant J is constant, within experimental error, with temperature for He I making this substance a fluid of the first kind. Helium II is a fluid of the second kind inasmuch as J is constant along an isotherm, but J varies with the temperature. The isotherms which cross the λ transition can be fitted with two straight lines, one for the He I region and one for the He II region. Plots of J , L , and J/L vs temperature are given. While the behavior of the J and L curves is abnormal, apparently the abnormalities are parallel in both constants, since the J/L curve is much more regular. The number average degree of association, the number of particles, and the volume of holes are calculated along the 2.00°K isotherm. There is a sudden jump of these quantities at the λ point. In going from He I to He II the degree of association increases; the number of particles and the volume of holes decreases. Apparently the structural change that occurs is an inversion. In He I the structure is that of a normal liquid like water, where it consists of larger particles joined by defects consisting of holes and smaller particles. At the λ point due to the lowering of the pressure the defect "continuum" becomes tenuous due to the increase in the volume of holes, and the bonds suddenly break. The skeleton of the structure of He II then becomes one of the large particles forming a loose network with the remains of the small particles which formerly formed the "continuum" occupying the free space in the network. These small particles are then the superfluid component of He II. (auth)

29824 SOLUTIONS TO THE PERCUS-YEVICK EQUATION. A. A. Broyles (Univ. of Florida, Gainesville). *J. Chem. Phys.*, 35: 493-6 (Aug. 1961).

The radial distribution function for a classical fluid of particles interacting with the Lennard-Jones potential was computed by solving the Percus-Yevick integral equation numerically. The solutions and the quantities, p/nkT and E/nkT , are compared with those obtained by Wood and Parker using Monte Carlo techniques. The radial distribution functions agree to better than 15% beyond the first points where they are unity while the thermodynamic quantities differ by at most, 3% from the range of Monte Carlo values for cases where the system is believed to be in a liquid state. The quantity $K = -(1/V) (\partial V / \partial p)_{N,T}$, was also computed. (auth)

29825 TAYLOR SERIES EXPANSION OF THE INTERMEDIATE COUPLING ENERGY LEVELS OF Nd^{3+} AND Er^{3+} . Eugene Y. Wong (Univ. of California, Los Angeles). *J. Chem. Phys.*, 35: 544-6 (Aug. 1961).

A Taylor series expansion of the intermediate coupling energy levels for Nd^{3+} and Er^{3+} was calculated. New energy levels can be calculated without rediagonalizing the matrix. A calculation for $NdCl_3$ is discussed. (auth)

29826 MASS SPECTRA AND METASTABLE TRANSITIONS IN ISOTOPIC NITROUS OXIDES. G. M. Begun and J. Landau (Oak Ridge National Lab., Tenn.). *J. Chem. Phys.*, 35: 547-51 (Aug. 1961).

The mass spectra of the four species $N^{14}N^{14}O$, $N^{14}N^{15}O$, $N^{15}N^{14}O$, and $N^{15}N^{15}O$ are recorded. The $(NO)^+$ fragment produced was found to be formed by rearrangement, as well as by loss of the end nitrogen. The mass spectrum of each of the nitrous oxides contained ions corresponding to metastable transitions. These ions were shown to arise from both spontaneous and collision induced dissociation of the parent molecule ion $(N_2O)^+$. The electron impact dissociation of nitrous oxide is discussed. (auth)

29827 ABSORPTION AND FLUORESCENCE SPECTRA WITH MAGNETIC PROPERTIES OF $ErCl_3$. G. H. Dieke and Shobha Singh (Johns Hopkins Univ., Baltimore). *J. Chem. Phys.*, 35: 555-63 (Aug. 1961).

The absorption and fluorescence spectra of $ErCl_3$ diluted by $LaCl_3$ are given with the Zeeman effects of many of the lines. All expected electronic levels to 30,000 cm^{-1} above the ground state are found, and their interpretation fits into the theoretically expected scheme. Examples are also given of the absorption and fluorescence spectrum of pure $ErCl_3$ which show that the pure salt must have a structure quite different from that of $LaCl_3$. (auth)

29828 APPROXIMATE ANALYTICAL WAVE FUNCTIONS FOR THE $1s^2ns^2S_{1/2}$ STATES OF Li AND Li-LIKE IONS. Z. W. Ritter, R. Pauncz, and K. Appel (Univ. of Uppsala). *J. Chem. Phys.*, 35: 571-5 (Aug. 1961).

Calculations have been made for the $1s^22s$, $1s^23s$, $1s^24s$, $1s^25s$, $2s^2$ states of Li and Li-like ions. The functional form used allows for radial correlation in the inner shell and gives sufficient flexibility for describing the outer electron. The energy values obtained for the ground state are the best among calculations which do not introduce interelectronic coordinates or angular correlation. The energy values for the excited states differ by not more than 1% from the experimental values. (auth)

29829 THEORY OF PROTON MAGNETIC SHIELDING. Marshall Fixman (Mellon Inst., Pittsburgh). *J. Chem. Phys.*, 35: 679-88 (Aug. 1961).

If an unsymmetrized product of molecular orbitals is used to represent the ground state of a molecule, the proton magnetic shielding is the sum of contributions from each molecular orbital. In the simplest variation theory of the perturbation of these orbitals by the proton magnetic dipole and an external magnetic field, the perturbation vanishes if the vector potential representing the external field is caused to vanish at the charge centroid of the orbital. Proton magnetic shielding constants are evaluated on this basis with molecular orbitals of the form $\psi(1) = [(1 - \gamma)\psi_0^2(1) + \gamma\psi_1^2(1)]^{1/2}$. This form was first examined by an energy variation on H_2 , the energy being minimized with respect to internuclear distance and a screening constant, and was then applied to proton magnetic shielding in H_2 . In subsequent calculations γ was evaluated from electric dipole moments when possible. Proton magnetic shielding constants were then evaluated for the C-H bond (methane, ethylene, and acetylene), the Group VI hydrides (H_2O , H_2S , H_2Se), and the hydrogen halides (HF, HCl, HBr, HI). (auth)

29830 A SIMPLIFIED ANALYSIS OF SPHERICAL AND CYLINDRICAL BLAST WAVES. Manfred P. Friedman (Massachusetts Inst. of Tech., Cambridge). *J. Fluid Mech.*, 11: 1-15 (Aug. 1961).

Investigations into the behavior of the gas flow behind spherical or cylindrical blasts have shown that secondary

shocks arise within the original detonation gases. The secondary shock, at first weak, is carried outward with the expanding gases. Subsequently it strengthens and bends back toward the origin, arriving there with high intensity. By using some recently developed techniques in shock dynamics and extending them where necessary, a theory is developed by which the motion of the main shock wave, as well as the formation and subsequent motion of the secondary shock, are given by explicit formulas. In addition, a method for determining, also by explicit formulas, the location of the contact surface between the detonation gases and the outside atmosphere is given. The results of a specific problem, which is solved by numerically integrating the total equations of motion, and is checked experimentally, are compared with the results of the present theory. (auth)

29831 MOLECULAR DISSOCIATION IN CHARGE-TRANSFER REACTIONS. Vladimir Cermak and Zdenek Herman (Inst. of Physical Chemistry, Czechoslovak Academy of Sciences, Prague). *Nucleonics*, 19: No. 9, 106; 108-14 (Sept. 1961).

Decomposition of polyatomic molecules excited by charge-transfer reactions was studied by modifying an ordinary mass spectrometer. Monoatomic ions transfer their positive charges to neutral molecules by taking electrons from them and thus leave the newly formed ions in excited states. These excited molecules decompose to form lighter ions in several ways, and some of these are discussed. Excitation by charge-transfer is advantageous in that the excitation energy is known to be the recombination energy of the atomic ion minus the ionization energy of the excited molecule. (L.N.N.)

29832 SOME PARTITION PROBLEMS WITH ANALOGIES IN QUANTUM STATISTICS. R. L. Ingraham (New Mexico State Univ., University Park). *Nuovo cimento* (10), 21: 29-35 (July 1, 1961). (In English)

The problem of counting configurations of spins in Ising lattices which satisfy various algebraic conditions is formally similar to computing the entropy of certain many-particle systems obeying Fermi-Dirac statistics. Steepest descent methods are used to solve several of these problems, and the analogies with quantum statistical formula noted. (auth)

29833 A METHOD FOR THE MEASUREMENT OF THE MOBILITY OF ELECTRIC CHARGES IN LIQUIDS. S. Cunsolo (Università, Padua and Istituto Nazionale di Fisica Nucleare, Padua). *Nuovo cimento* (10), 21: 76-83 (July 1, 1961). (In English)

A new technique for measuring the mobility of electric charges in liquids is developed. One essentially measures the time of flight between a grid and the collecting electrode which is connected to an electrometer by a suitable filter. This method is easy to apply and the experimental results are in excellent agreement with those obtained in liquid helium by others. (auth)

29834 THE SUPPLEMENTARY CONDITION IN QUANTUM ELECTRODYNAMICS. C. A. Hurst (Univ. of Adelaide). *Nuovo cimento* (10), 21: 274-93 (July 16, 1961). (In English)

A presentation of the supplementary condition in quantum electrodynamics is given which is free from normalization difficulties even with a definite metric. The supplementary condition is treated as a generator of a commutative sub-algebra in the ring of field operators. This sub-algebra generates an ideal in its own commutator algebra, and the corresponding remainder ring is the set of all physical

gage invariant operators. Any representation of this remainder ring is free from normalization difficulties. The relationship of this approach to that of Fermi, Candlin and Gupta is discussed. (auth)

29835 ON THE BORN-LERTES ROTATIONAL EFFECT. W. F. Pickard (Harvard Univ., Cambridge, Mass.). *Nuovo cimento* (10), 21: 316-32(July 16, 1961). (In English)

A unified theoretical treatment of the Born-Lertes rotational effect is presented for the special case of a system of two concentric cylinders. It is shown that both the Born and the Lertes effects arise naturally from the concepts of dielectric loss and effective conductivity. A typical theoretical curve is given for the variation of the torque with frequency. (auth)

29836 ELECTRICAL RESISTIVITY, HALL EFFECT AND SUPERCONDUCTIVITY OF SOME b.c.c. TITANIUM-MOLYBDENUM ALLOYS. R. R. Hake, D. H. Leslie, and T. G. Berlincourt (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). *Phys. and Chem. Solids*, 20: 177-86(Aug. 1961). (In English)

The electrical resistivities and the Hall coefficients of a series of body centered cubic Ti-Mo alloys have been measured between 1.1°K and room temperature, in magnetic fields up to 30 kgauss, and for concentrations of Mo between 7 and 24 at %. For the lower Mo concentration alloys the resistivities are high (≈ 140 microhm cm), and are slightly larger at 4.2 than at 300°K. The resistivities decrease with increase of Mo over the entire range of alloy concentrations studied. The Hall coefficients are positive and are appreciably concentration and temperature dependent only below solute concentrations of about 12 at % Mo. The alloys are all superconducting at liquid helium temperatures, their resistive superconducting transition temperatures increasing with increase of Mo. Atomic ordering and structural transformation, concentration and temperature dependent electronic factors, and spin-disorder scattering are considered as possible explanations for the anomalous concentration and temperature dependence of the resistivity. (auth)

29837 X-RAY YIELDS IN THE K AND L SERIES OF μ -MESONIC ATOMS. J. L. Lathrop, R. A. Lundy, V. L. Telegdi, and R. Winston (Univ. of Chicago). *Phys. Rev. Letters*, 7: 147-50(Aug. 15, 1961).

Previous experimental results (NSA 11: 5984) gave yields of x rays in the K and L series of light μ -mesic atoms, requiring that the Auger rates competing with radiative transitions be respectively ~ 300 times (K series) or ~ 30 times (L series) as fast as predicted by conventional theory or else that some hithertofore unknown competitive transition mechanism be postulated. In view of this, yields in the π -mesic K and L series were remeasured, in particular for those light elements for which low or unobservable yields have been reported. Preliminary results are presented graphically and tabularly that do not confirm those previously published. (L.N.N.)

29838 ZEEMAN EFFECT IN THE GROUND MULTIPLY OF SAMARIUM. F. M. J. Pichanick and G. K. Woodgate (Oxford Univ.). *Proc. Roy. Soc. (London)*, A263: 89-100(Aug. 22, 1961).

The values of g_j for all the levels of the ground term F^7 of samarium were measured by the method of magnetic resonance in an atomic beam. A theoretical calculation of some of the corrections to the Landé g -value is presented. These corrections arise from the breakdown of Russell-

Saunders coupling and from relativistic and diamagnetic effects. While the numerical agreement with experiment appears superficially to be good, it is shown, by a consideration of the J -dependence of the theoretical corrections, that certain significant discrepancies remain. A new measurement of g_j for the ground state of europium is also reported and discussed. It is g_j ($\text{Eu}^8\text{S}^{7/2}$) = 1.99340 ± 0.00007 . (auth)

29839 THE THEORY OF THE SUPERCONDUCTIVE STATE. H. Frölich (Univ. of Liverpool). *Repts. Progr. in Phys.*, 24: 1-23(1961).

The development of the theory of the superconductive state is described in terms of simple physical ideas so far as this has been found possible. (auth)

29840 GENERATION OF HIGH POWER RADIO-FREQUENCY PULSES BY MEANS OF AN EXPLODING WIRE TECHNIQUE. Ieuan R. Jones (Aerospace Corp., Los Angeles) and Ralph F. Wuerker. *Rev. Sci. Instr.*, 32: 962-3(Aug. 1961).

A method of generating high power radio-frequency pulses is described which utilizes the "current dwell" period which can occur when a thin wire is exploded by means of a high current. The rf oscillation occurs in a resonant circuit placed in series with the exploding wire. A circuit is described in which is obtained a 6- μ sec duration pulse of 2.74 Mc oscillations. (auth)

29841 ANALYTICITY OF PERTURBATION EXPANSIONS. T. S. Chang (Academia Sinica, Peking). *Sci. Sinica (Peking)*, 10: 426-35(Aug. 1961). (In English)

Nambu's theory on the analyticity of perturbation expansions is applied to the change of analyticity of a square diagram—the simplest four-point diagram—upon insertion of internal lines. It is proved that for N - π and π - π scattering the insertion of any number of internal lines, provided they are all parallel to one of the sides (the ladder approximation), does not affect the original analyticity; and the insertion of two internal lines, each connecting a pair of opposite sides, does affect the original analyticity, but the resulting analyticity is still compatible with the assumptions in the theory of double dispersive relations. (auth)

29842 DEPENDENCE OF CONCENTRATION OF M AND F CAPTURE CENTRES ON THE RADIATION DOSE OF X-RAYS. T. Sh. Davitashvili. *Trudy Inst. Fiz. Akad. Nauk Gruz. S.S.R.*, 7: 89-98(1960). (In Georgian)

Thermoluminescence of KCl single crystals irradiated with x rays at room temperature was studied. The dependence of the peak sizes, caused by the thermoionization of M and F centers, on the time of x irradiation was established. The form of this dependence is explained by participation of neutral vacancy complexes, existing in real single crystals before the irradiation, in the formation of M centers, and by participation of single vacancies, generated during the irradiation, in the formation of F centers. (auth)

29843 SOME PROPERTIES OF THE CURVATURE OF THE ELECTRONOPTICAL IMAGE IN MAGNETIC FIELDS. O. I. Seman. *Trudy Inst. Fiz. i Astron., Akad. Nauk Eston. S.S.R.*, No. 13, 20-37(1961). (In Russian)

An arbitrary choice of image curvature is impossible. Coefficients of curvature are subject to limitations connected with parameters of Gaussian optics. Such limitations are represented in the form of inequalities that do not include distributions of field between conjugate points. Sagittal curvature is constant in sign and greater than a certain positive quantity. Limitations for meridional curvature de-

pend essentially on the location of the diaphragm. Deduced formulae allow the exclusion of regions of the diaphragm for which a correction of curvature is impossible. For the meridional curvature of extremely short lenses to have positive values, it is sufficient that magnification m satisfy the condition $-4 < m < -\frac{1}{4}$, regardless of the co-ordinates of the diaphragm. Astigmatism is not subject to limitations which exist for other curvature coefficients. Curvature coefficients are represented by convenient positive forms in the case of which the accumulation of errors is reduced to a minimum, and which are applicable to experimental field distribution data. The formulas obtained are in accordance with relativity. There is a quantitative dependence of the curvature coefficients of magneto-immersion systems upon initial field tensities and normal coefficients of aberration. This dependence is expressed in a simple formula which takes account of the normal coefficients of curvature, spherical aberration and anisotropic coma. There are no grounds for asserting that the curvature of image in magnetic fields is incorrigible. Such assertions are due to the obvious generalization for arbitrary fields of results applicable in the case of short fields only. (auth)

29844 ON THE METHOD OF FINITE DIFFERENCES IN QUANTUM MECHANICS. R. A. Preem. Trudy Inst. Fiz. i Astron., Akad. Nauk Eston. S.S.R., No. 13, 38-66 (1961). (In Russian)

An attempt is made to construct quantum mechanics in one dimension on the basis of finite displacements. The state vector is indicated to be a 2-spinor, and the problem of eigenvalues is formulated making use of their extremal nature, but now the eigenvalues may be in general, complex numbers. Possible application to complex planes is mentioned. (L.N.N.)

29845 EQUATIONS FOR CHARGED PARTICLE MOTION IN CLASSICAL ELECTRODYNAMICS. Yu. P. Pyt'ev. Vestnik Moskov. Univ., Ser. III, 16: No. 2, 9-11 (Mar.-Apr. 1961). (In Russian)

A method of evaluating emissions from charged particles in motion in an electromagnetic field is discussed. (R.V.J.)

29846 CONTINUOUS COMPLETE GREEN'S FUNCTIONS. I. S. Shapiro and Yu. V. Gaponov (Inst. of Scientific Research in Nuclear Physics, [USSR]). Vestnik Moskov. Univ., Ser. III, 16: No. 2, 73-81 (Mar.-Apr. 1961). (In Russian)

A method is suggested for developing complete Green functions as expansions of continuous integrals along trajectories. In the general case, Green functions are in infinite series according to the number of virtual fermion pairs. Closed expressions are developed when vacuum polarization is not considered. (R.V.J.)

29847 THE TREATMENT OF MANY-BODY PROBLEMS OF SOLID-STATE PHYSICS. Günter Sauermann (Technische Hochschule, Munich). Z. Physik, 163: 435-50 (1961). (In German)

Theoretically a solid body is considered as a coupled system of electrons and atomic nuclei. In order therefore to obtain suitable equations for electrons and nuclei alone, one must usually proceed from the existence of a periodic crystal structure. On the other hand it was shown that under the assumption that the kinetic energy of the nucleus is small with respect to the total energy, an electron equation can be derived in which a reaction of the nucleus enters into the expression. Simultaneously it results that the stopping probability of the nucleus is the concentration around an equilibrium position for which in monoatomic lattices a periodic arrangement is favorable. (tr-auth)

29848 PRODUCTION OF PROLONGED PULSE MAGNETIC FIELDS. E. S. Borovik and A. G. Limar (Khar'kov Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zhur. Tekh. Fiz., 31: 939-43 (Aug. 1961). (In Russian)

An attempt was made to determine conditions for the effective development of a prolonged-pulse magnetic field. Experiments with industrial copper wire showed that lowering the temperature to 20°K produced a 100-fold decrease in resistivity; the resistivity of pure copper and aluminum was reduced 1000-fold. It was found that by using pure materials at low temperature, the coefficient of energy transformation can be considerably increased. A device can be developed through which almost all the energy following the pulse can be returned to condensers. (R.V.J.)

29849 SOME ANGULAR CONFORMITIES OF CATHODE SPUTTERING. I. I. Dushkov, V. A. Molchanov, V. G. Telkovskii, and V. M. Chichero (Leningrad Inst. of Semiconductors). Zhur. Tekh. Fiz., 31: 1012 (Aug. 1961). (In Russian)

The influence of current-produced magnetic fields on the motion of electrons in vacuum and in plasma thermoelements is analyzed. Calculations show that though the influence is small, it imposes certain limitations on electrode dimensions. (R.V.J.)

29850 THEORETICAL HYDRODYNAMICS. Fourth Edition. L. M. Milne-Thomson. New York, The Macmillan Company, 1960. 685p.

A clear and methodical introductory exposition is given of the mathematical theory of fluid motion which will be useful in applications to both hydrodynamics and aerodynamics. The mathematical theory is presented consistently on vector methods and notation with their natural consequence in two dimensions, the complex variable. The previous mathematical knowledge required does not go beyond the elements of the infinitesimal calculus. The necessary additional mathematical apparatus is introduced as required. (N.W.R.)

29851 SMALL PARTICLE STATISTICS. An Account of Statistical Methods for the Investigation of Finely Divided Materials. G. Herdan. With a Guide to the Experimental Design of Particle Size Determinations. M. L. Smith, W. H. Hardwick, and P. Connor. Second Revised Edition. New York, Academic Press Inc., and London; Toronto; Sydney; Wellington, New Zealand; and Durban, Union of South Africa; Butterworths, 1960. 437p.

An account is given of statistical methods for the investigation of finely divided particles in the sieve and sub-sieve size range. The mathematical method developed for dealing with the problems of small particle statistics is to start with the problems and gradually develop the statistics step by step as far as possible systematically. No knowledge of statistics is needed since the mathematical functions are derived in a simple way and are shown by numerical examples and tables. Included in this volume is statistical methods for nuclear particles. (N.W.R.)

29852 ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS. VOLUME XIV. L. Marton, ed. New York, Academic Press, 1961. 348p. \$11.00.

Six papers are presented, covering such topics as semiconductors, quadrupole lens systems, hydrogen thyatron, and microwave generation and transmission. All the papers are abstracted separately. (T.F.H.)

29853 THE ELECTRON AS A CHEMICAL ENTITY. C. G. B. Garrett (Bell Telephone Labs., Inc., Murray Hill,

N. J.). p.1-35 of "Advances in Electronics and Electron Physics. Volume XIV." New York, Academic Press, 1961.

A study is made of the equilibrium states of systems in which at least one of the phases is a semiconductor. A thermodynamic approach is used to find the semiconductors' internal and interphase equilibrium conditions. Statistical mechanics is applied to find the Fermi-Dirac distribution functions for the semiconductor phases. Effects of impurities and imperfections are studied. Experimental results on Ge, Si, and ZnO are reviewed. (T.F.H.)

29854 PROBLEMS OF PHOTOCONDUCTIVITY.

P. Görlich (Inst. for Optics and Spectroscopy, German Academy of Sciences, Berlin and Friedrich Schiller Univ., Jena, Ger.). p.37-84 of "Advances in Electronics and Electron Physics. Volume XIV." New York, Academic Press, 1961.

Photoconductivity characteristics of semiconductors are studied. Attention is devoted to photoconduction in the base lattice and tail absorption regions; carrier lifetimes; reaction kinetics; photocurrent rise and decay, saturation, and dependence upon radiation intensity; effects of dislocations on photoconductivity; negative photoconductivity; photoelectromagnetic effects; junctions and contacts; and the effects of the semiconductor surface conditions upon the photoconductivity. A survey is presented of the properties and uses of photoconductors. (T.F.H.)

29855 STRONG-FOCUSING LENSES. Albert Septier (Université, Paris). p.85-205 of "Advances in Electronics and Electron Physics. Volume XIV." New York, Academic Press, 1961.

Theoretical and practical aspects of quadrupole (strong-focusing) lenses are studied. The optical properties of singlet, doublet, and triplet lens systems are discussed. The magnetic field characteristics and the equations of motion are examined. Various configurations (e.g. helical poles, stacked lenses, etc.) are outlined. Types of aberrations are studied, and means for correcting them are given. Several magnetic and electrostatic lenses are shown. Experimental methods for determination of the optical properties of these lenses are reviewed. (T.F.H.)

29856 HYDROGEN THYRATRONS. Seymour Goldberg and Jerome Rothstein (Edgerton, Germeshausen and Grier, Inc., Boston). p.207-64 of "Advances in Electronics and Electron Physics. Volume XIV." New York, Academic Press, 1961.

A survey is presented of high-power hydrogen thyratrons. Replenishers or reservoirs are described whose purpose is to make up for H cleanup during operation. Ceramic envelopes are discussed. The characteristics of the conduction interval are detailed, including inverse conduction problems, deionization and recovery, cathode utilization and dissipation, breakdown of the grid-cathode space, fall of anode potential and anode dissipation, and commutation of the discharge to the anode. The influences of these theoretical investigations on hydrogen thyatron design are noted. (T.F.H.)

29857 ČERENKOV RADIATION AT MICROWAVE FREQUENCIES. Herbert Lashinsky (Columbia Univ., New York). p.265-97 of "Advances in Electronics and Electron Physics. Volume XIV." New York, Academic Press, 1961.

The general theory of Cherenkov radiation is reviewed. The use of the Cherenkov effect to obtain tunable, coherent microwave radiation is investigated. The design of microwave Cherenkov devices, utilizing bunched electron beams traveling near dielectric media, is outlined. (T.F.H.)

29858 HIGH-POWER AXIAL-BEAM TUBES. T. Moreno (Varian Associates, Palo Alto, Calif.). p.299-329 of "Advances in Electronics and Electron Physics. Volume XIV." New York, Academic Press, 1961.

A review is presented of the designs and characteristics of high-power klystrons and traveling-wave tubes. Problems common to these types of tubes, such as cathode materials, electron beam formation and control, output window design, and collector design, are discussed. The gain, power, and broadbanding characteristics of klystrons and traveling-wave tubes are compared. (T.F.H.)

Astrophysics and Cosmology

Refer also to abstract 28878

29859 (NASA-TN-D-1079) IONOSPHERIC RESULTS WITH SOUNDING ROCKETS AND THE EXPLORER VIII SATELLITE (1960 ξ). R. E. Bourdeau (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). Aug. 1961. 22p.

A review is made of ionospheric data reported since the IGY from rocket and satellite-borne ionospheric experiments. These include rocket results on electron density (RF impedance probe), D-region conductivity (Gerdien condenser), and electron temperature (Langmuir probe). Also included are data in the 1000 kilometer region on ion concentration (ion current monitor) and electron temperature from the Explorer VIII satellite (1960 ξ). The review includes suggestions for second generation experiments and combinations thereof particularly suited for small sounding rockets. (auth)

29860 (NASA-TR-R-120) THEORETICAL DETERMINATION OF THE FORM OF THE HOLLOW PRODUCED IN THE SOLAR CORPUSCULAR STREAM BY INTERACTION WITH THE MAGNETIC DIPOLE FIELD OF THE EARTH. John R. Spreiter and Benjamin R. Briggs (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.). 1961. 53p.

The interaction between a neutral stream of ionized solar corpuscles and a three-dimensional magnetic dipole representing the geomagnetic field is investigated. It is assumed that the stream is confined to the exterior and the magnetic field to the interior of a hollow, the boundary of which is defined by a thin current sheath. An approximate method of solution is applied, and results are presented for the coordinates of the trace of the boundary of the hollow in the meridian plane containing the sun-earth line and the dipole axis for several relative orientations. Results are presented for the trace in the equatorial plane for the case in which the dipole axis is normal to the sun-earth line. The corresponding problem in two dimensions is considered, and it is shown that the analogous approximate results are in good agreement with the results indicated by an exact solution of the same basic equations. (auth)

29861 (NASA-TT-F-72) SOLAR RADIO PHENOMENA AND THEIR PHYSICAL INTERPRETATION. J. F. Denisse (National Aeronautics and Space Administration, Washington, D. C.). Translation of "Les Phenomenes Radioelectriques Solaires et Leur Interpretation Physique." Sept. 1961. 10p.

Presented at the 13th General Assembly of the Union Radio Scientifique Internationale in London, Sept. 12, 1960.

The various types of waves that can arise in the coronal plasma and the conditions for their escape beyond the co-

rona are discussed. The centimeter bursts of radiation and type-IV bursts can be interpreted as synchrotron radiation of relativistic electrons. The bursts of type III and type II are most probably caused by the excitation of oscillations of the coronal plasma by high-energy particles; but whereas the particles responsible for type III seem to pass through the corona freely, those which radiate type II are probably trapped in a magneto-dynamic wave. Radio storms are probably caused by the excitation of oscillations of the coronal plasma by particles initially ejected during an eruption, these particles remaining trapped for several days in the permanent magnetic configurations near the sun. (auth)

29862 COSMIC RAYS ON EARTH AND IN THE UNIVERSE. V. L. Ginzburg. *Uspekhi Fiz. Nauk*, 74: 521-52 (July 1961). (In Russian)

The data on the composition of cosmic rays having an energy of 10^{12} to 10^{13} ev are reviewed. It is pointed out that these cosmic rays consist principally of "bare" nuclei of protons, light elements, heavy elements, and very heavy elements. Electrons and positrons compose less than 1% of the composition of the cosmic rays. It would be highly desirable to have more accurate information on the number of positrons and electrons in these cosmic rays and on the chemical composition of cosmic rays at very high energies ($E > 10^{16}$ ev). A proton nucleus, or some other kind of nucleus with an energy of 10^{14} to 10^{19} ev collides with N and O atoms of the air and forms a shower of high energy particles which can be studied by a set of counters connected in coincidence. Although the energy of the primary particle can be found, the composition is unknown. Since cosmic rays fall isotropically on earth, it is conjectured that a charged particle interacts with a magnetic field and irradiates electromagnetic waves, including radio waves. It is proposed that the supernovae produce cosmic rays in large amounts and that radiowaves are also emitted in this process which can be detected by the methods of radioastronomy. It is shown by a rough energy balance that supernovae explosions contain enough energy to account for the observed concentration of cosmic rays in the universe. New and more exact data about cosmic rays in supernovae and spiral galaxies can be obtained by the methods of radioastronomy and astrophysics. (TTT)

Cosmic Radiation

29863 (AFCRC-TN-59-425) PROTONS IN AURORAE. Scientific Report No. 2. A. Omholt (Oslo. Universitetet. Institutt for Teoretisk Astrofysikk). 1959. Contract AF61(514)-1123. 16p. (AD-232263)

Hydrogen lines $H\alpha$ (6563) and $H\beta$ (4860) were found in the auroral spectra and it was concluded that showers of H atoms or protons occasionally enter the atmosphere during an aurora. The protons entering the atmosphere, following the magnetic lines of force at very high energy, capture electrons from air molecules and atoms and emit spectral lines with a Doppler displacement. Present knowledge of this spectrum indicates that auroras are primarily caused by other types of fast particles which may be electrons. The evidence of x rays in the auroral zone, interpreted as bremsstrahlung from electrons, may favor the assumption that both electrons and protons enter the earth's atmosphere during auroras. The main difficulty for the theory of electric discharges as a source of auroras is the high conductivity in the ionosphere. The dispersion in the initial velocity of the protons and the latitude effects are other

facts that have to be accounted for by a theory of the aurora. (B.O.G.)

29864 (INSJ-41) FINE STRUCTURE OF THE CORE OF EXTENSIVE AIR SHOWERS. H. Hasegawa, T. Matano, I. Miura, M. Oda, G. Tanahashi, and Y. Tanaka (Tokyo Univ. Inst. for Nuclear Study). July 1, 1961. 10p.

The lateral distribution of extensive air showers was studied in which the fine density structure of the core was observed with a neon hodoscope and an array of scintillation counters. Photographs are included showing the various core types observed. A plausible explanation is discussed for the observed fluctuations in the core structures. (B.O.G.)

29865 (NASA-TN-D-412) THE FLUX AND ENERGY SPECTRA OF THE PROTONS IN THE INNER VAN ALLEN BELT. John E. Naugle and Donald A. Kniffen (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). Aug. 1961. 6p.

A cylindrical stack of G-5 nuclear emulsions housed in the payload section of a four-stage research rocket was flown into the northern edge of the inner Van Allen belt on September 19, 1960. The experimental design permitted, for the first time, measurements of the particle fluxes and energy spectra as functions of position along the rocket trajectory. Eight points along the trajectory were selected for analysis. Results are presented for three of the points, and are discussed in light of various theories on the trapped radiation. (auth)

29866 (NP-10652) THE HISTORY OF COSMIC RADIATION AS REVEALED BY ISOTOPIC CHANGES IN THE METEORITES AND ON THE EARTH. J. Geiss, H. Oeschger, and U. Schwarz (Bern. Universität. Physikalisches Institut). [1961]. 43p.

Lecture presented at the Varenna Summer Course on Cosmic Rays, Solar Particles and Space Research, May 1961.

Those aspects of meteorites, the earth's atmosphere, and the lunar surface which have a bearing on cosmic radiation and solar radiation studies are emphasized. Included are studies of spallation products and induced activities contained in meteorites, layers of ice masses, and deep sea sediments. (J.R.D.)

29867 PHOTOGRAPHY OF ČERENKOV LIGHT FROM EXTENSIVE AIR SHOWERS IN THE ATMOSPHERE. D. A. Hill (Massachusetts Inst. of Tech., Cambridge) and N. A. Porter. *Nature*, 191: 690 (Aug. 12, 1961).

An image intensifier system, triggered by amplified pulses from a 5-in. photomultiplier, was used to photograph Cherenkov light from extensive air showers. It is suggested that the method may be of value in the search for showers initiated by primary γ rays. (C.H.)

29868 A COMPARISON OF PION AND NUCLEON INTERACTIONS IN NUCLEAR EMULSIONS BETWEEN 10^{11} AND 10^{13} eV. F. A. Brisbout, C. Gauld, C. B. A. McCusker, J. Malos, K. Nishikawa, L. S. Peak, and L. G. Van Loon (Univ. of Sydney). *Nuclear Phys.*, 26: 217-21 (1961). (In English)

Using data obtained from a 10-liter emulsion stack by the Sydney group and a 22-liter stack by the Chicago group it is shown that at energies around 1000 Bev: a) the average number of shower particles in secondary jets (mainly produced by pions) is about half that in jets produced by protons, b) the spread of multiplicities in pion-nucleon encounters at a given energy is small, c) the spread of multiplicities in proton produced jets is considerable

and in good agreement with the predictions of tunnel theory assuming a geometric interaction cross section for protons, and d) the average number of heavy prongs in secondary jets (mostly produced by pions) decreases with increasing energy for about 15 at 6 Bev to about 3 at 5000 Bev. (auth)

29869 PRIMARY COSMIC RAY α -PARTICLES.

[PART] II. A. Engler, F. Foster, T. L. Green, and J. Mulvey (Oxford Univ.). *Nuovo cimento* (10), 20: 1157-65 (June 16, 1961). (In English).

Results of an investigation of the flux and energy spectrum of cosmic ray α -particles in August 1958 at a geomagnetic latitude of 61° N are presented. The modulation mechanism recently proposed by Elliot is shown to provide a good description of the change in the energy spectrum between times of minimum and maximum solar activity. (auth)

29870 COSMIC RAY EVENTS IN NOVEMBER 1960.

A. M. Conforto and N. Iucci (Università, Rome; Istituto Nazionale di Fisica Nucleare, Rome; and Commissione Italiana Cooperazione Geofisica Internazionale, [Rome]). *Nuovo cimento* (10), 21: 294-300 (July 16, 1961). (In English)

The principal cosmic ray (C.R.) events of a group of solar and geophysical phenomena observed on November 10 to 15, 1960 are reported. Particular attention is called to the C.R. increase recorded on November 12 at high latitude stations ($\geq 45^\circ$ geom.) and in the nucleonic component only, to its second, well distinct peak and to certain peculiarities of the whole phenomenon. In order to explain the 5 hours delay in the access to the earth of the solar C.R. producing this enhancement, it seems necessary to look for some "storage" mechanism and some release process thereafter. (auth)

29871 FURTHER MEASUREMENTS OF THE SIZE-SPECTRUM OF EXTENSIVE AIR SHOWERS.

J. R. Green and J. R. Barcus (Univ. of New Mexico, Albuquerque). *Nuovo cimento* (10), 21: 361-8 (July 16, 1961). (In English)

Measurements on the size spectrum of extensive air showers were made over a period of about one year to include approximately 10^5 events. It is found that errors of about 5% in determining the number of particles traversing the scintillator make it impossible to observe time variations of less than 8%. For showers containing a total number of particles $10^5 < N < 10^7$, the spectrum for vertical incidence is $K_{\nu}(\geq N) = (2.26 \pm 0.14) \times 10^{-7} (N/10^6)^{-(1.540 \pm 0.006)} \text{ s}^{-1} \text{ m}^{-2} \text{ sr}^{-1}$. (auth)

29872 THE INFLUENCE OF ISOTOPIC COMPOSITION ON THE MAXIMUM IN THE COSMIC RAY ENERGY SPECTRA.

M. V. K. Appa Rao and M. F. Kaplon (Univ. of Rochester, N. Y.). *Nuovo cimento* (10), 21: 369-72 (July 16, 1961). (In English)

The previously found maximum in the cosmic radiation energy spectrum is discussed, and the possibility that it arises in part from a misinterpretation of the data due to oversimplifying assumptions about the composition of the beam is examined. The importance that lack of recognition of isotopic composition may have is pointed out, and it is clear that this importance is strongly dependent on the measurements made and on the cut-off rigidity. (L.N.N.)

29873 SEARCH FOR HIGH-ENERGY COSMIC GAMMA RAYS.

Thomas L. Cline (Massachusetts Inst. of Tech., Cambridge). *Phys. Rev. Letters*, 7: 109-12 (Aug. 1, 1961).

The γ radiation intensity is measured as a function of

atmospheric depth, from 0 to 1200 g/cm^2 . The γ counting rate follows a transition curve having a maximum at about 180 g/cm^2 . With a 95% confidence limit, an extrapolated upper limit of $7 \cdot 10^{-3} \text{ cm}^{-2} \text{ sec}^{-1} \text{ sterad}^{-1}$ is set to the γ intensity at 0 g/cm^2 . An upper limit is also set for the annihilation and creation rates of antiprotons, at $2.5 \cdot 10^{-23} \text{ cm}^{-3} \text{ sec}^{-1}$. (T.F.H.)

29874 TIME VARIATIONS OF DIRECTIONAL COSMIC RAY INTENSITY AT LOW LATITUDES. I. COMPARISON OF DAILY VARIATION OF THE INTENSITY OF COSMIC RAYS INCIDENT FROM EAST AND WEST.

U. R. Rao and V. Sarabhai (Physical Research Lab., Ahmedabad, India). *Proc. Roy. Soc. (London)*, A263: 101-17 (Aug. 22, 1961).

A study was conducted at Ahmedabad during 1957 and 1958 of the time variations of meson intensity incident from east and west at 45° to the vertical. A characteristic difference of about 6 h in the diurnal time of maximum for the east and west directions is observed to occur on many days and this was interpreted as signifying an anisotropy of primary radiation caused by a source outside the influence of the geomagnetic field. However, there are many days on which the daily variation has a maximum near noon for both directions. On such days the predominant influence is that of a local source situated within the influence of the geomagnetic field. The local source is associated with geomagnetically disturbed days. Long-term changes in the daily variation are found to be similar for the east, vertical and west directions. (auth)

29875 TIME VARIATIONS OF DIRECTIONAL COSMIC RAY INTENSITY AT LOW LATITUDES. II. TIME VARIATIONS OF EAST-WEST ASYMMETRY.

U. R. Rao and V. Sarabhai (Physical Research Lab., Ahmedabad, India). *Proc. Roy. Soc. (London)*, A263: 118-26 (Aug. 22, 1961).

Changes of the energy spectrum of primary cosmic radiation are followed through the time variations of east-west asymmetry of the μ meson component at low latitudes. Such a study was conducted for the first time at Ahmedabad during 1957-8. The changes of east-west asymmetry are associated with changes of the daily variation of cosmic ray intensity, of the daily mean neutron intensity measured at equatorial and middle latitude stations, of the index of geomagnetic disturbance and of the horizontal component of the earth's magnetic field. The study indicates that days with high east-west asymmetry are associated with geomagnetically quiet days and a cosmic ray daily variation consistent with its being produced by an anisotropy of primary radiation outside the influence of the geomagnetic field. On such days, the daily variation produced by the anisotropy, as observed at an equatorial station, has a significant diurnal as well as a semi-diurnal component. High east-west asymmetry and associated anisotropy occur 3 to 5 days before the arrival of solar corpuscular beams which envelop the earth. Days with low east-west asymmetry occur about 3 to 4 days after the onset of cosmic ray storms associated with geomagnetic storms, usually of the SC type. (auth)

29876 TIME VARIATIONS OF DIRECTIONAL COSMIC RAY INTENSITY AT LOW LATITUDES. III. INTERPRETATION OF SOLAR DAILY VARIATION AND CHANGES OF EAST-WEST ASYMMETRY.

U. R. Rao and V. Sarabhai (Physical Research Lab., Ahmedabad, India). *Proc. Roy. Soc. (London)*, A263: 127-35 (Aug. 22, 1961).

The daily variation of cosmic ray intensity at low latitudes can under certain conditions be associated with an anisotropy of primary radiation. During 1957-8, this anisotropy had an energy spectrum of variation of the form $ae^{-0.8 \pm 0.3}$

and corresponded to a source situated at an angle of $112 \pm 10^\circ$ to the left of the earth-sun line. The daily variation which can be associated with a local source situated along the earth-sun line has an energy spectrum of variation of the form ae^0 . Increases in east-west asymmetry and the associated daily variation for east and west directions can be explained by the acceleration of cosmic ray particles crossing beams of solar plasma in the neighborhood of the earth. For beams of width 5×10^{12} cm with a frozen magnetic field of the order of 10^{-4} gauss, a radial velocity of about 1.5×10^8 cm/s is required. The process is possible only if the ejection of beams takes place in rarefied regions of interplanetary space which extend radially over active solar regions. An explanation of Forbush type decreases observed at great distances from the earth requires similar limitation on the plasma density and conductivity of regions of interplanetary space. The decrease of east-west asymmetry associated with world-wide decreases of intensity and with SC magnetic storms is consistent with a screening of the low-energy cosmic ray particles due to magnetic fields in plasma clouds. (auth)

29877 ON THE PROBLEM OF SELECTION OF EXTENSIVE AIR SHOWERS WITH THE GIVEN NUMBER OF PARTICLES AND OF DETERMINATION OF THEIR ELECTRON PHOTON COMPONENT. E. L. Andronikashvili, M. F. Bibilashvili, E. N. Dekanosidze, and R. E. Kazarov. Trudy Inst. Fiz. Akad. Nauk Gruzin. S.S.R., 7: 3-18(1960). (In Georgian)

A tunnel 150 m long with varying depth, the maximum depth about 200 mwe, was made for investigating the penetrating component in extensive air showers. A ramified system of selecting devices was built on the earth's surface above the tunnel. The preliminary calculations of the system on the earth's surface and detection and determination of showers are given. Optimum parameters for such a system and the optimum conditions of observation were determined with a computer. (auth)

29878 TRANSITION EFFECT OF STARS IN DENSE ABSORBERS. T. V. Varsimashvili. Trudy Inst. Fiz. Akad. Nauk Gruzin. S.S.R., 7: 19-27(1960). (In Georgian)

The results of experiments made at 3100 m above sea level are given. The experiments were made by means of photographic layers for the purpose of defining more precisely the curve of the transition effect of stars in lead and of observing the transition effect in graphite. Experiments made with a graphite absorber give the value of the transition effect directly and exclude the geometry of the apparatus. An analysis of the influence of scanning efficiency on the observed value of the transition effect is given. The value of the transition effect of stars in lead is 30% and in graphite 10 to 15%. (auth)

29879 ON THE PAPER BY K. H. HÖCKER, H. KUHN AND M. RITZI: "ABSORPTION ANALYSIS OF THE STAR-PRODUCING COMPONENT OF COSMIC RAYS." T. V. Varsimashvili. Trudy Inst. Fiz. Akad. Nauk Gruzin. S.S.R., 7: 29-35(1960). (In Georgian)

The explanation of the transition effect of stars offered by K. H. Höcker, H. Kuhn, and M. Ritzl is considered. They offered a two particle mechanism. One of the particles is a charged particle, the second is a neutral product of its decay at rest in the absorber. The secondary particle has the geometrical cross section of the nuclear interaction and produces stars of the transition effect. It is shown that such a scheme does not agree with experimental data. (auth)

Criticality Studies

29880 (ANL-6404) THE COEFFICIENT OF VOLUME EXPANSION FOR WATER AND WATER VAPOR IN THE CRITICAL REGION. Technical Report No. 6. E. S. Nowak and R. J. Grosh (Purdue Research Foundation, Lafayette, Ind.). Aug. 1961. For Argonne National Lab. Contract AT(11-1)-1026, Subcontract 31-109-38-704. 17p.

A tabulation is presented of the coefficients of volume expansion for water and for water vapor along eleven isobars in the critical region encompassed by pressures from 3000 to 4000 psia and temperatures from 690 to 750°F. Graphical techniques were employed to derive these values from precise P-V-T data. The over-all error in the derived values of the volume expansion coefficient was estimated to be within 5%. However, in the region of maximum values for the coefficient of volume expansion along the various isobars, the uncertainty in the derived values was estimated to be between 5 to 30%. (auth)

29881 (K-1335(Del.)) APPLICATION OF INTERACTION CRITERIA TO HETEROGENEOUS SYSTEMS. H. F. Henry, C. E. Newlon, and J. R. Knight (Oak Ridge Gaseous Diffusion Plant, Tenn.). June 4, 1957. Decl. with deletions July 24, 1961. Contract W-7405-eng-26. 21p.

Recent experimental criticality data with homogeneous and heterogeneous systems of interacting containers were used in evaluating an interaction principle for the safe storage and handling of dissimilar containers of fissionable materials. The experimental data which included slab and cylindrical geometries, U-235 assays of 93.2%, and H/U-235 atomic ratios from 0 to 330, and which extend below the useful range of a two-group theory previously used to evaluate interaction experiments, indicate that the principle is valid over the wide range of criticality parameters considered, and that a homogeneous system of interacting containers is, in general, more highly reactive than any corresponding heterogeneous one. An analysis was also made of the safety of cylindrical storage units where criticality control is based upon mass rather than upon geometric limitations. Calculations using a two-group interaction theory indicate that, for containers meeting ORGDP safe interaction criteria, either uniform dilution or concentration of the fuel from an optimum H/U-235 ratio of about 600 will result in a smaller container separation being required. (auth)

29882 (NAA-SR-6446) EXPONENTIAL EXPERIMENTS WITH HEAVY-WATER, GRAPHITE-AND-DIPHENYL MODERATED, URANIUM METAL LATTICES. R. W. Campbell and C. H. Skeen (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 15, 1961. Contract AT-11-1-GEN-8. 37p

A series of experiments were carried out during the past several years to study the basic reactor physics of several clean lattices and their constituents. Three moderators, heavy water, graphite, and diphenyl were used, in turn, in these lattices. Three metal fuels (but not mixtures thereof) were used. The fuel enrichments (at.%) were 0.4962 (depleted), 0.7205 (natural) and 0.9124 (enriched). The fuel elements made from 4-inch long slugs, were in the form of a cylinder which had a diameter of one inch. These elements were 5 ft long. These experiments are summarized and simplified two group theoretical comparison of the results is presented. It is demonstrated that this model is not accurate for the description of these lattices. (auth)

29883 (NDA-2131-38) A METHOD FOR CALCULATING THE REACTIVITY OF D₂O-MODERATED NATURAL

URANIUM LATTICES WITH CLUSTERED ROD FUEL ELEMENTS. H. Soodak and R. Sullivan (United Nuclear Corp., White Plains, N. Y.). June 15, 1961. Contract AT(30-1)-2303(IX). 69p.

A method is presented for calculating the reactivity of D_2O -moderated lattices with natural U or UO_2 fuel rods. The method is based on the use of collision probabilities, treating the fuel cluster as a structure of subcells within the lattice cell. Formulas are derived for calculating ϵ , ρ , f , L^2 , and τ ; η is left as an input parameter that can be empirically fitted to measurements. Cross sections to be used in calculations with this method are given. Comparison with measurements on 22 clustered rod lattices gave buckling agreement within 9% without adjustment of η . (auth)

29884 (TID-12619) CRITICAL MEASUREMENTS FOR THE KIWI-A NUCLEAR PROPULSION TEST REACTOR. J. C. Hoogterp and J. D. Orndoff (Los Alamos Scientific Lab., N. Mex.). [nd]. 45p.

Reactor mockup measurements are reported which contributed to the design of the Kiwi-A reactor. Initial surveys of critical parameters and fission power distributions were conducted in the Honeycomb machine, and the fuel element loadings and controls were finalized by the Zepo machine. Zero-power measurements on the Kiwi-A reactor confirmed the Zepo results. (D.L.C.)

29885 (AEC-tr-4803) CONTROL OF A SUBCRITICAL ATOMIC REACTOR. J. Lacour and V. Raievski. Translated by Helen Basil for Argonne National Lab., Ill. from *Onde élec.*, 38: 592-9(1958). 22p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 14, Abstract No. 2176.

29886 DETERMINATION OF THE CRITICAL CONDITION BY THE MULTIPLE COLLISION METHOD. [PART] II. Takami Asaoka (Japan Atomic Energy Research Inst., Tokyo). *J. At. Energy Soc. Japan*, 3: 531-40(July 1961). (In English)

Further development of the multiple collision method is presented. The critical condition for a monoenergetic neutron source was obtained by finding the pole of a Laplace transform for total neutron variation with time. The so-called c , the mean number of secondaries per collision, was calculated within an error less than 10^{-5} for every critical system with finite thickness. The asymptotic total number of neutrons in the system after a sufficiently long time was also derived. Finally, comparing the derived critical condition with that from diffusion theory, the extrapolation distance was evaluated accurately for a system with thickness less than several times the neutron mean free path. (auth)

Elementary Particles and Radiations

29887 (AERE-R-3782) POLARIZATION IN MUON SCATTERING. R. J. N. Phillips (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1961. 16p.

The theory of polarization experiments is described, for elastic muon scattering from protons or light spinless nuclei, and Born approximation formulas are given. The possible value of such experiments is discussed. (auth)

29888 (CF-61-7-20) THE RELATIVISTIC DOPPLER PROBLEM. C. D. Zerby, R. B. Curtis, and H. W. Bertini (Oak Ridge National Lab., Tenn.). July 12, 1961. 17p.

Equations are derived for high-energy nuclear cascade calculations. Attention is given to the motion of the nucleons in the nucleus, which gives rise to a relativistic Doppler effect when a high-energy particle is incident on the nucleus. The effects of the exclusion principle are included in the derived equations. (auth)

29889 (NP-10595) RESEARCH INVESTIGATION DIRECTED TOWARD EXTENDING THE USEFUL RANGE OF THE ELECTROMAGNETIC SPECTRUM. Sixth Quarterly Progress Report, March 16, 1961 through June 15, 1961. R. Novick (Columbia Univ., New York. Columbia Radiation Lab.). June 15, 1961. Contract DA-36-039 SC-78330. 44p. (CU-6-61-SC-78330-Phys.).

Several 6-mm magnetrons were developed for the microwave cavity particle detector and several tracks were observed with the apparatus. A report is given on radio-astronomical measurements at 21 cm. A 50 kMc rutile maser was developed for use in conjunction with the radio-astronomical observation of NVII in the sun's corona, for which a preliminary search was made. Results are given for paramagnetic relaxation size effect studies on copper Tutton salt. Experiments with pulsed ruby and cesium vapor optical maser systems are described. An experiment on second sound in liquid helium II is outlined. Preliminary results are given for optical pumping of radioactive cadmium isotopes, as well as for level crossing experiments. Progress is described on an experiment involving the interaction of molecules and conducting surfaces. Several atomic beam studies are described, including work on lithium and O^{15} . A high sensitivity optical resonance apparatus is described. (auth)

29890 (UCRL-9712) AN EXPERIMENTAL DETERMINATION OF THE K_1^0 - K_2^0 MASS DIFFERENCE (thesis). Robert Peter Matsen (California. Univ., Berkeley. Lawrence Radiation Lab.). May 22, 1961. Contract W-7405-eng-48. 70p.

A 1.1-Bev/c π^- beam interacts with protons to produce a beam of K^0 mesons. The long-lived K_2^0 component of the K^0 's emitted in the forward direction strikes an iron plate in a propane bubble chamber. The K_2^0 beam interacts with the iron nuclei of the plate to regenerate approximately 100 K_1^0 mesons. These are detected in the propane behind the plate by their characteristic $K_1^0 \rightarrow \pi^+ + \pi^-$ decay mode. A study of the K_1^0 angular distribution—in particular, the unscattered or coherent events as compared with the scattered events—yields information on the K_1^0 - K_2^0 mass difference. In order to obtain quantitative results, a theoretical description of the K_1^0 angular distribution, including both interference and multiple scattering, is constructed. The K_1^0 regeneration and K_2^0 scattering amplitudes are derived from optical-model calculations, and the unknown K^0 and \bar{K}^0 optical potentials are replaced by the charge-independent K^+ and K^- potentials. A substantial coherent peak is observed and indicates with odds of 600 to 1 that $\delta < 1.6$; δ is the mass difference measured in units of $\hbar/\tau_1 = 6.58 \times 10^{-6}$ ev. Because of the lack of precise experimental information on the K^0 and \bar{K}^0 optical-model potentials, the possibility of zero mass difference—although it appears unlikely—cannot be ruled out by this experiment. The most probable value is $\delta = 0.74_{-0.23}^{+0.28}$. (auth)

29891 (UCRL-9752) HYPERON PRODUCTION BY K^- MESONS INCIDENT ON HYDROGEN (thesis). William E. Humphrey (California. Univ., Berkeley. Lawrence Radiation Lab.). June 12, 1961. Contract W-7405-eng-48. 92p.

A study is presented of production and decay properties of Σ and Λ hyperons produced by K^- interactions in a

hydrogen bubble chamber. Approximately 90% of the hyperons were produced by K^- -p interactions at rest, and the remaining 10% were produced by K^- mesons with laboratory momentum < 275 Mev/c. The observed hyperon decay rates from this experiment yield the hyperon mean life times: $\tau_{\Sigma^-} = 1.58 \pm 0.06 \times 10^{-10}$ sec, $\tau_{\Sigma^+} = 0.765 \pm 0.04 \times 10^{-10}$ sec, and $\tau_{\Lambda} = 2.69 \pm 0.11 \times 10^{-10}$ sec. The observed branching ratios for Σ^+ and Λ decay are $(\Sigma^+ \rightarrow \pi^+ + n)/[(\Sigma^+ \rightarrow \pi^+ + n) + (\Sigma^+ \rightarrow \pi^0 + p)] = 0.490 \pm 0.024$ and $(\Lambda \rightarrow \pi^- + p)/[(\Lambda \rightarrow \pi^- + p) + (\Lambda \rightarrow \pi^0 + n)] = 0.643 \pm 0.016$. The K^- -p interactions occurring at rest yield hyperon production rates in the ratio $\Sigma^- : \Sigma^+ : \Lambda = 0.447 : 0.208 : 0.281 : 0.064$. The in-flight K^- -p interactions appear to be dominated by the hyperon production process. The absorption cross section is nearly geometric for s-wave interactions throughout the observed laboratory momentum range between 75 and 275 Mev/c. Angular distributions for the hyperon production processes are all quite consistent with isotropy. An s-wave zero-effective-range analysis of the K^- -p elastic, charge exchange, and absorption processes was carried out. The scattering lengths which best fit the data of this experiment are: $A_0 = -0.220 + 2.742i$ for the isotopic spin-0 channel, and $A_1 = 0.019 + 0.384i$ for the isotopic spin-1 channel. (auth)

29892 (JPRS-9934(p.64-74)) THE RADIATIVE CAPTURE OF μ -MESON BY PROTON. Yuan-pent Tai (Y. B. Dai), Ting-ch'ang Hsien (D. C. San), Cha-hsiu Ho (T. H. Ho), and Hung-yuan Chu (H. Y. Tzu). Translated from Wu Li Hsüeh Pao, 15: 262-8 (May 1959).

The radiative capture of μ mesons by protons was studied using the renormalized universal Fermi interaction of the V-A type and Zel'dowich's theory of μ -mesic hydrogen. It was found that if the effect of the strong interaction is neglected, then it is impossible for a photon to be emitted during the capture. The influence of the strong interaction was found to consist of two parts: the effect of the magnetic moment of the nucleon and the renormalization effect on the universal Fermi weak interaction. The effect of the anomalous magnetic moment was negligible. However, the contribution of the proton to the emission of the photon was not at all small in comparison with that of the μ meson due to the renormalization effect on the universal Fermi weak interaction. As a result, the protons emitted were not 100% right-hand polarized. It was estimated that only 80% of the photons have a spin parallel to their momentum. The radiative capture rate of the meson (μ) by the proton was $1/1.6 \times 10^5$ of the total capture rate. (auth)

29893 CLASSICAL RELATIVISTIC MOTION OF A POLE PARTICLE UNDER THE ACTION OF EXTERNAL AND PROPER SCALAR FIELDS. I. Abonyi (Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung., 13: 11-19 (1961). (In English)

The classical relativistic equations of motion of a pole particle subjected to scalar fields are investigated. It can be shown that in the case of a free particle the equations of motion admit a rigorous solution which corresponds to the uniform rectilinear motion. The probable existence of the runaway solutions is mentioned. It is shown that in a special case the particle can move uniformly along a straight line even under the action of a constant external field. The variation of the rest mass is studied on the basis of this example and it is pointed out that the proper field of the particle gives no contribution to the rest mass. An analog of Eliezer's integral theorem is derived for a particle moving in a central scalar field. Finally it is shown in a certain approximation that the particle cannot perform a uniform

circular motion under the action of the force derived from the Yukawa potential. (auth)

29894 PROPAGATORS WITH DIPOLE GHOSTS FOR FERMION FIELDS. K. L. Nagy (Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung., 13: 21-4 (1961). (In English)

The spectral representation of propagators for relativistic fermion fields was calculated in field theories, where the existence of dipole ghost states with $p_0 \geq 0$ are assumed. This general result is compared with a form obtained by Mitter in a certain approximation for a Heisenberg type of theory. (auth)

29895 ON THE HIGH ENERGY BEHAVIOUR OF THE PION-NUCLEON ELASTIC SCATTERING AMPLITUDE. G. Domokos (Central Research Inst. for Physics, Budapest). Acta Phys. Acad. Sci. Hung., 13: 89-97 (1961). (In English)

The kinematics of (π , N) elastic scattering is treated in the quasiclassical approximation. It is shown that if a quasiclassical limit exists, then spin-effects become negligible at sufficiently high pion energies, independently of other details of the interaction. An asymptotic representation of a function defined by means of a Hilbert transform is given. The latter is used to derive the asymptotics of the (π , N) forward scattering amplitude. The possibility of testing the results experimentally is discussed. (auth)

29896 CALCULATING THE PROBABILITY OF THE AUGER EFFECT. M. A. Listengarten (Leningrad State Univ.). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz., 25: 792-8 (July 1961). (In Russian)

The calculated values of the relative intensities of the lines of the K-LL group of Auger electrons differ by 30 to 50% from the experimental results for elements with an average atomic number, and by a factor of 3 to 4 for heavy elements with a large atomic number ($Z > 80$). This divergence was due to the fact that relativistic effects were not taken into account in the calculations. On applying quantum relativistic theory of the slowing down interaction of two charges, equations were derived from which the probabilities of the Auger transitions could be calculated on a computer. The calculated probabilities are compared with other calculated probabilities where relativistic effects were not taken into account, and with experimental values. The results show that the total probability of the K-LL-transitions calculated by means of relativistic wave functions exceed the corresponding non-relativistic values by more than a factor of two. The $K-L_1L_1$ and the $K_1-L_1L_2$ Auger transitions are increased by the greatest amounts. This result is completely in accord with the experimental results. The K-fluorescence yield for an element with $Z = 81$ was calculated as 0.962, while the average experimental value of the K-fluorescence yield is 0.955. Calculations for the probabilities of Auger transitions are being continued at $Z > 90$, and also at $Z \sim 60$. (TTT)

29897 DESCRIPTION OF STRONG COUPLING AND THE RESONANCE PROBLEM IN MESON-NUCLEON SCATTERING. Helmut Jahn (Max-Planck-Institut für Physik und Astrophysik, Munich). Nuclear Phys., 26: 353-419 (1961). (In German)

A discussion is presented of the strong-coupling method in meson field theory. By means of a canonical and non-linear transformation of variables the original meson field is split into a free meson part and a self-field part of the nucleon. The transformation is defined so that the interaction between the compound nucleon system thus arising and the free mesons vanishes in the case of infinitely strong

coupling. It is shown that there exists a family of transformations satisfying the conditions. A system of equations for certain transformation functions is stated as the consequence of the conditions. The solutions of the field-splitting problem are investigated. The general scheme for a strong-coupling approximation method based on this field splitting is derived, and the problem of calculating the pion-nucleon resonance scattering from the strong coupling theory is treated on this basis. A special approximation is made for calculations near the resonance. Numerical results obtained from such a calculation are discussed. The symmetric scalar fixed-source meson theory is used, but the principle of the method is the same in the more essential but more complicated symmetric pseudoscalar case. Thus the present considerations serve to guide an analogous investigation using the symmetric pseudoscalar theory. (auth)

29898 THE NEW PARTICLES AND THE BARYON MASS SPECTRUM. A. I. Solomon (Laboratoire de Physique Théorique et Hautes Energies, Orsay, France). Nuclear Phys., 26: 452-6(1961). (In English)

A study is made of the effects of the new strange particles which complete the Gell-Mann-Nishijima scheme on the mass levels of the baryons, from the point of view of perturbation theory. It is shown that the observed baryon mass spectrum ordering may be obtained by a suitable choice of parities. (auth)

29899 PHASE SHIFT CALCULATIONS ON α - α SCATTERING. E. W. Schmid and K. Wildermuth (Florida State Univ., Tallahassee and Oak Ridge National Lab., Tenn.). Nuclear Phys., 26: 463-8(1961). (In English)

The α - α scattering phase shifts are calculated, with two-nucleon forces that describe the low-energy two-nucleon scattering data. (auth)

29900 DIRECT ELECTRONIC DECAY OF THREE π^0 'S EMITTED FROM AN ANTINEUTRON ANNIHILATION STAR. Tsai-chü and C. Simonin-Haudecœur (Faculté des Sciences, Paris). Nuovo cimento (10), 20: 1102-14(June 16, 1961). (In English).

Continuous search for antineutron annihilation events in an antiproton stack leads to the discovery of a star of $10 + 15n$. Of the fifteen shower particles of this star, twelve are identified as electrons and three as pions. A negative pion among the three comes to rest. The ten heavy prongs contain only evaporation protons. All the protons come to rest in the emulsion and each proton has a kinetic energy less than 15 Mev. Dividing the twelve electrons into three groups and assuming each group as the decay of $\pi^0 \rightarrow e^+ + e^- + e^-$, one can evaluate the masses of the three π^0 's respectively, as (136 ± 14) , (135 ± 14) , and (136 ± 13) Mev. The probability for the simultaneous decay of three ordinary π^0 's is only 4×10^{-14} . This event suggests the possibility of a new process for the production of electrons, e.g., the existence of a second π^0 . Considering the high multiplicity, the wide angular distribution and the right average energy of the pions as well as the total energy of the star, one concludes that this event is the result of an annihilation between an antineutron and a nucleon. A small-cell technique is proposed for the measurement of the multiple scattering of the inclined minimum-ionizing tracks. (auth)

29901 INTERNAL PAIRS FROM π^- -PROTON INTERACTIONS AT REST. H. Kobrak (Enrico Fermi Inst. for Nuclear Studies, Chicago). Nuovo cimento (10), 20: 1115-32(June 16, 1961). (In English).

Examples of internal pair production in pion-proton interactions at rest were recorded in hydrogen bubble cham-

ber photographs. These pairs originate in the reaction $\pi^- + p \rightarrow n + e^+ + e^-$ and in the decay $\pi^0 \rightarrow \gamma + e^+ + e^-$. These events were analyzed to find the experimental distribution in the mass of the pair and another variable related to the energy partition between the members of the pair. These distributions were compared with a theory which includes corrections due to nucleon form factors and radiative corrections. The experimental results are in good agreement with this theory. Longitudinal virtual photon contributions are necessary to properly describe the experimental results for radiative capture pairs and as predicted theoretically are not visible for π^0 pairs. In accord with present theory, the form factor effects are found to be small for both reactions. (auth)

29902 AN INVESTIGATION OF POSSIBLE BOUND Σ -HYPERON-NUCLEON SYSTEMS AND THEIR DECAY. A. K. Common (University Coll., London). Nuovo cimento (10), 20: 1133-47(June 16, 1961). (In English).

The binding of Σ -hyperons to nucleons is investigated using potentials suggested by field theory. Special attention is paid to the possibility that the Σ^- -hyperon can bind to a neutron while the Σ^+ -hyperon and proton are unbound. Tables are given showing the effect of changes in the coupling constants. The lifetime of this hypothetical bound (Σ^-, n) system is calculated, and it is shown that, for certain forms of the weak Hamiltonian responsible for the decay, the interaction in the final state between the two nucleons can be neglected. It is also found that the effect of the Pauli principle in the final state is appreciable even if the (Σ^-, n) system is assumed to have a binding energy less than 1 Mev. (auth)

29903 ASSOCIATED PRODUCTION OF STRANGE PARTICLES. M. Gourdin (Faculté des Sciences, Orsay, France and Faculté des Sciences, Bordeaux, France) and M. Rimpault. Nuovo cimento (10), 20: 1166-81(June 16, 1961). (In English).

A model is presented for calculating the associated production of strange particles. It is shown that the complexity of the unitarity condition makes the dispersion relation technique very difficult and probably unsuccessful. The amplitude of the reaction is taken as a sum of terms due on the one hand to the Born approximation and on the other hand to the resonances (pion-nucleon, pion-hyperon, pion-meson K). The different possibilities for the intrinsic parities still poorly known should be considered. One comparison of the model with experimental results is under way but the experimental data is very inaccurate and incomplete, making over-all conclusions and precise answers to the problems posed very difficult. (tr-auth)

29904 ON THE SYMPLECTIC SYMMETRY. A. Salam (Imperial Coll., of Science and Tech., London) and J. C. Ward. Nuovo cimento (10), 20: 1228-30(June 16, 1961). (In English).

It is pointed out that the Salam-Polkinghorne theory admits of the (unitary) symplectic group in four dimensions and the associated vector mesons in this case also including K^* , is used. (L.N.N.)

29905 THEORY OF LEPTONS. [PART] I. E. C. G. Sudarshan (Univ. of Rochester, N. Y.). Nuovo cimento (10), 21: 7-28(July 1, 1961). (NYO-9552). (In English)

A finite relativistic theory of four-fermion interactions is formulated; the theory involves as an essential ingredient the use of an indefinite metric. The problems of interpretation raised by the use of the indefinite metric are analyzed in relation to the observables and structure of many-particle states in quantum field theory; and the con-

sistency of the interpretive postulate is demonstrated. The theory incidentally provides a *raison d'être* for the muon. (auth)

29906 TWO-PARTICLE STRUCTURE OF THE MANDELSTAM REPRESENTATION. W. Zimmermann (Inst. for Advanced Study, Princeton, N. J.). *Nuovo cimento* (10), 21: 36-58 (July 1, 1961). (In English)

The two-particle contributions to the Mandelstam representation of the scattering amplitude are separated for the three reaction channels simultaneously. (auth)

29907 ON THE "QUASI-ELASTIC DIFFRACTION" SCATTERING OF HIGH-ENERGY PROTONS. B. T. Feld and Chikashi Iso (CERN, Geneva). *Nuovo cimento* (10), 21: 59-68 (July 1, 1961). (In English)

The observations to Cocconi, et al., on the quasi-elastic diffraction scattering of (10 to 25) BeV/c protons by nucleons, are explained as resulting from isobar excitation of the target nucleons. The experiments are shown to provide evidence on the excitation of the first three levels. Some physical arguments are presented concerning the nature of the excitation process and its energy and angular dependence. (auth)

29908 THE ERIKSEN TRANSFORMATION IN THE CASE OF PARTICLES WITH SPIN 0 AND 1. H. Högaasen (Univ. of Oslo, Blindern, Norway). *Nuovo cimento* (10), 21: 69-75 (July 1, 1961). (In English)

It is shown how Eriksen's transformation can be used in the reduced Kemmer theory, and how this simplifies scattering and spin precession of the vector particle. (auth)

29909 OPTICAL MODEL POTENTIAL FOR K^- MESON-NUCLEUS SCATTERING. A. D. Martin (University Coll., London). *Nuovo cimento* (10), 21: 88-97 (July 1, 1961). (In English)

The two-body scattering lengths, which describe the interaction between K^- mesons and free nucleons are used to calculate an optical model potential representing the interaction between K^- mesons and nuclei. The cross sections for the scattering of K^- mesons by emulsion nuclei are calculated numerically from this potential and are found to conform closely with the experimental values. (auth)

29910 REMARKS ON THE NUCLEAR ABSORPTION OF NEGATIVE PIONS IN DEUTERIUM. E. G. Beltrametti (Università, Genoa and Istituto Nazionale di Fisica Nucleare, Genoa). *Nuovo cimento* (10), 21: 98-106 (July 1, 1961). (In English)

The correlation between the polarization of the neutrons emitted in the capture reaction $\pi^- + d \rightarrow 2n$ is examined. It is found to be simply related to the state of the absorbed pion, providing a means of separating the contributions to the process from *s* and *p* states of the meson. A possible extension to the capture in complex nuclei is briefly sketched. (auth)

29911 ON A GENERALIZED FOLDY-WOUTHUYSEN TRANSFORMATION. C. G. Bollini and J. J. Giambiagi (Universidad, Buenos Aires). *Nuovo cimento* (10), 21: 107-18 (July 1, 1961). (In English)

It is shown that while the Lorentz transformation operates in a space with an indefinite Lorentz invariant metric, the Foldy transformation operates in a space with a positive definite euclidean metric. This correspondence is extended to any spin. A particular discussion is given for the spin 1 case, for which a hamiltonian equation is proposed. (auth)

29912 DIFFRACTION SCATTERING OF ELEMENTARY PARTICLES. P. T. Matthews and A. Salam (Impe-

rial Coll. of Science and Tech., London). *Nuovo cimento* (10), 21: 126-34 (July 1, 1961).

The diffraction scattering of elementary particles is discussed. It is pointed out that there is a possibility of charge exchange diffraction scattering, except when it is inhibited at very high energy by the Pomerančuk theorem. The notion of inelastic diffraction scattering, recently discussed by Good and Walker, is reformulated in relation to the field theory of unstable particles. (auth)

29913 ON THE $\mu \rightarrow 3e$ DECAY AS A TEST OF THE APPLICABILITY OF THE PERTURBATION EXPANSION IN THE THEORY OF WEAK INTERACTIONS. J. Nilsson (CERN, Geneva). *Nuovo cimento* (10), 21: 135-44 (July 1, 1961). (In English)

As a test of the applicability of the perturbation expansion in the theory of weak interactions the $\mu \rightarrow 3e$ decay is considered. The weak interactions are given in the usual current \times current form including quadratic terms like $(\bar{e}\nu)(\bar{\nu}e)$. The best value so far available for the branching ratio $\mu \rightarrow 3e/\mu \rightarrow e + \nu + \bar{\nu}$ then requires a cut-off at 90 BeV to make the theoretical predictions compatible with the experimental findings. This cut-off is in agreement with the cut-off obtained in $\mu \rightarrow e + \gamma$ decay discussed earlier by Ioffe. (auth)

29914 NEUTRAL SCALAR σ -MESON AND THE MASS DIFFERENCE BETWEEN MUON AND ELECTRON. K. Tanaka (Istituto di Fisica Teorica, Mo. ra d'Oltremare, Naples and Argonne National Lab., Ill.). *Nuovo cimento* (10), 21: 169-76 (July 1, 1961). (In English)

The self-mass arising from the interaction of a leptonic field with a scalar neutral σ meson is calculated in perturbation theory to examine the possibility that the electron may be regarded as a light muon because the sign of the self-mass is negative. Further, the consequences of a model in which a leptonic field interacting with the σ meson can describe the electron and muon as eigenstates are studied. (auth)

29915 SEARCH FOR LEPTONIC AND RADIATIVE DECAYS OF CHARGED Σ -HYPERONS. G. Quarenì (Università, Bologna and Istituto Nazionale di Fisica Nucleare, Bologna), A. Quarenì Vignudelli, K. Gottstein, I. Laboragine, and A. Salandin. *Nuovo cimento* (10), 21: 177-81 (July 1, 1961). (In English)

No leptonic decays were observed in a large sample of charged Σ hyperons (about 600 $\Sigma^+ \rightarrow \pi^+ + n$). Taking into account the efficiency of the method used for the analysis of the events, the ratio $(e^+ + \nu + n)/(\pi^+ + n)$ is less than 1%, in accord with other authors. No $\Sigma^+ \rightarrow \pi^+ + \gamma + n$ events, with π^+ of energy less than 75 MeV, were detected. Up to now only two examples have been reported in the literature. Then the ratio $(\pi^+ + \gamma + n)/(\pi^+ + n)$ lies probably between 1 and 2%, consistent with theoretical predictions. (auth)

29916 GAUGE COVARIANCE OF SPINOR GEOMETRY. A. Peres (Israel Inst. of Tech., Haifa). *Nuovo cimento* (10), 21: 182-3 (July 1, 1961). (In English)

A generalization of some of Bergmann's results concerning the gauge covariance of spinor geometry is presented. It is shown that the covariant derivatives of the pseudospinors of different weights correspond to particles of different charges. An implication of the theory discussed is that the vector involved is only partly determined by the electromagnetic potential: its real part is fixed only up to the multiplicative constant, while its imaginary part is arbitrary and perhaps devoid of physical interest. (N.W.R.)

29917 A SIMPLE DERIVATION OF THE GEODESIC EQUATIONS OF MOTION FROM THE MATTER TENSOR

IN GENERAL RELATIVITY USING THE δ -FUNCTION.

D. K. Sen (Univ. of Toronto). *Nuovo cimento* (10), 21: 184-5 (July 1, 1961). (In English)

A simple derivation of the geodesic equations of motion of a system of particles from the field equations, similar to Jordan's except that the equation of continuity is used, is described. (N.W.R.)

29918 THE CONTRIBUTION OF THE BORN TERMS TO PHOTOPRODUCTION OF PIONS AT HIGH ENERGIES. G. Höhler, K. Dietz, and A. Müllensiefen (Technische Hochschule, Karlsruhe, Ger.). *Nuovo cimento* (10), 21: 186-9 (July 1, 1961). (In German)

In the photoproduction of pions (neutral and positive), there are large differences between the calculated Born cross sections and the experimental data which cannot be accounted for only by the resonance terms. It is known that there exists a large non-resonant effect of the final state interaction which partially compensates the magnetic Born term in the case of the neutral pion. It is not definite that the effect is small compared with the second order multipole transition because of the magnetic term. In order to demonstrate that the same term is responsible for the compensation, the angular distribution for the neutral pion is calculated. It is shown that the magnetic Born term is essential to the production amplitude. In the case of positive pion production the magnetic Born term is smaller, but there seems to exist a similar compensating effect, because the electric Born term alone represents the general behavior of the non-resonant part of the amplitude. (N.W.R.)

29919 A MODEL FOR K^0/K^+ BRANCHING RATIOS FOR Σ PRODUCTION IN HIGH ENERGY π^- -p COLLISIONS. H. Pilkuhn (Univ. of Stockholm). *Nuovo cimento* (10), 21: 190-3 (July 1, 1961).

By measuring the K^0/K^+ branching ratio for Σ^- production, $r_- \equiv \sigma(\pi^- + p \rightarrow \Sigma^- + K^0 + n \cdot \pi) / \sigma(\pi^- + p \rightarrow \Sigma^- + K^+ + n \cdot \pi)$, it is possible to decide whether the $\pi\pi$ or the πK interaction is the important one. Moreover, for the πK interaction, a specific model is suggested, and predictions are obtained not only for r_- , but also for r_+ and r_0 (the corresponding K^0/K^+ ratios for Σ^+ and Σ^0 , Λ^0 production). The possible influence of a $K\pi$ resonance interaction is mentioned. (N.W.R.)

29920 PION-PION INTERACTION AND PROTON-ANTIPROTON ANNIHILATION AT REST. V. De Alfaro (Istituto Nazionale di Fisica Nucleare, Turin) and B. Vitale. *Nuovo cimento* (10), 21: 197-9 (July 1, 1961). (In English)

Three related points are discussed concerning the pion annihilation of proton-antiproton pairs at rest, namely: the validity of the Day, Snow, and Sucher argument in favor of absorption from S initial states; the indication on the spin state of the annihilating pair, derived from the observed pion states; and the influence of a $T = J = 1$ resonant pion-pion state on the angular and energy distributions of the produced pions. From this discussion a more suitable choice of the annihilation process is analyzed to improve the sensitivity of the result to the existence of a pion-pion resonance in the $T = J = 1$ state and to give some useful indications on the most plausible solution of the first two mentioned points. (N.W.R.)

29921 IDENTIFICATION OF HEAVY HYPERNUCLEI FROM K^- CAPTURE BY PRIMARY STAR ANALYSIS. P. E. Schlein and W. E. Slater (Univ. of Chicago). *Nuovo cimento* (10), 21: 213-34 (July 16, 1961). (In English)

Several hypernuclei of $A \geq 7$ were uniquely identified

from an analysis of the parent K^- capture reactions. This method has proved of great value in the choice of the correct identity when the decay process offered various alternative interpretations. An example of the decay $C_{\Lambda}^{13} \rightarrow \pi^- + N^{13}$, $B_{\Lambda} = (10.8 \pm 0.5)$ Mev was thus identified for the first time. A second example of the decay $B_{\Lambda}^{12} \rightarrow \pi^- + 3He^4$, $B_{\Lambda} = (9.9 \pm 0.6)$ Mev is reported, confirming the previous observation. Some progress is made in resolving the composition of a group of heavy two-body decays. None of the events studied is inconsistent with K^- capture on light nuclei (C, N, O); two events require a two-nucleon capture process. (auth)

29922 ON THE BINDING ENERGIES OF MESIC HYPERNUCLEI. Y. Prakash, P. H. Steinberg, D. A. Chandler, and R. J. Prem (Univ. of Maryland, College Park). *Nuovo cimento* (10), 21: 235-48 (July 16, 1961). (In English)

A detailed analysis of 76 mesic decays of hypernuclei, found in a G-5 emulsion stack exposed to stopping K^- -meson beam at Berkeley is reported. The binding energies of the known decay modes are in good agreement with previously reported values. A value for the binding energy of H_{Λ}^3 is given based on data reported and in the literature. Some new and rare decay modes are observed and discussed. (auth)

29923 ANALYTIC BEHAVIOR OF THE SCATTERING AMPLITUDE AT ZERO ENERGY. W. Zimmermann (Inst. for Advanced Study, Princeton, N. J.). *Nuovo cimento* (10), 21: 249-73 (July 16, 1961). (In English)

It is shown that the scattering amplitude has a two-sheeted branch point at zero kinetic energy. The analytic continuation into the second sheet is discussed. (auth)

29924 RECURRENCE RELATIONS IN ISOSPIN FOR STATISTICAL WEIGHTS. H. Pilkuhn (Univ. of Stockholm). *Nuovo cimento* (10), 21: 301-4 (July 16, 1961). (In English)

For statistical charge probabilities in multiple production processes, recurrence relations in isospin are derived. Taken together with an explicit formula for isoscalar charge probabilities, these relations are the most convenient means for numerical calculations for large particle numbers and low isospin. (auth)

29925 ON THE EXISTENCE OF SOLUTIONS OF THE PION-PION DISPERSION EQUATIONS. [PART] I. C. Lovelace (Imperial Coll. of Science and Tech., London). *Nuovo cimento* (10), 21: 305-15 (July 16, 1961). (In English)

It is proved that the Chew-Mandelstam equations for pion-pion scattering with both S and P waves possess no exact solution, with the possible exception of solutions oscillating at infinity. The usual iteration procedures for solving these equations are only asymptotically convergent in the low energy region, the convergence being worse the larger the P wave. A cut-off is therefore unavoidable. Since the expansion of the Chew-Mandelstam equations with S and P waves in powers of the coupling constant is known to be consistent in all finite orders, this is an example of a theory in which the exact solution behaves worse than any order of the perturbation expansion. (auth)

29926 THE INVARIANT AMPLITUDES OF INTERACTION PROCESSES. A. C. Hearn (Trinity Coll., Cambridge, Eng.). *Nuovo cimento* (10), 21: 333-45 (July 16, 1961). (In English)

A systematic method of producing, where possible, invariants for a scattering process such that the associated amplitudes are free from kinematical singularities is derived. It is conjectured that such amplitudes cannot be found for most processes involving an odd number of pho-

ons. The results are proved completely in perturbation theory, but a method of proof independent of perturbation theory is outlined. Invariants for the elastic scattering of pions and deuterons, and nucleon Compton scattering are derived as examples. General interaction processes are also discussed. (auth)

29927 FUNCTIONAL METHODS FOR COMPOSITE PARTICLES. G. C. Wraith (Trinity Coll., Cambridge, Eng.). *Nuovo cimento* (10), 21: 352-60 (July 16, 1961). (In English)

It is shown how Symanzik's functional formalism can be extended to the case of many fields of arbitrary spin, which may form composite particles of arbitrary spin and mass spectra. It is shown that this can be done whether or not interpolating fields exist for the composite particles, and that the s -matrix is the same in either case. (auth)

29928 ON THE NEUTRON-PROTON MASS DIFFERENCE. G. Papini (The University, Leeds, Eng.). *Nuovo cimento* (10), 21: 373-5 (July 16, 1961). (In English)

The neutron-proton mass difference is re-evaluated on the basis of new experimental data and knowledge from high-energy electron scattering that the electromagnetic form factors of the proton can no longer be considered as identical. Calculations are performed using second order perturbation in e . There seems to be no modification if the perturbation theory is used instead of a dispersion technique. (L.N.N.)

29929 PARTICLE PRODUCTION BY 10-30 BeV PROTONS INCIDENT ON Al AND Be. W. F. Baker, R. L. Cool, E. W. Jenkins, T. F. Kycia, S. J. Lindenbaum, W. A. Love, D. Lüers, J. A. Niederer, S. Ozaki, A. L. Read, J. J. Russell, and L. C. L. Yuan (Brookhaven National Lab., Upton, N. Y.). *Phys. Rev. Letters*, 7: 101-4 (Aug. 1, 1961).

The production of \bar{p} , mesons (π^\pm), and mesons (K^\pm) by the interaction of protons on Al and Be targets is studied at energies of 10, 20, and 30 BeV. The production ratios and momenta of these particles are measured at angles of 4.75, 9, 13, and 20°. (T.F.H.)

29930 FAST ATOMIC TRANSITIONS WITHIN μ -MESONIC HYPERFINE DOUBLETS, AND OBSERVABLE EFFECTS OF THE SPIN DEPENDENCE OF MUON ABSORPTION. R. Winston and V. L. Telegdi (Univ. of Chicago). *Phys. Rev. Letters*, 7: 104-7 (Aug. 1, 1961).

Experiments for verifying the existence of a hyperfine structure effect in the doublet ground state of the μ -mesic atom are proposed. The structure causes nonlinearity in the time dependence of the μ meson decay rate; this effect, however, is quite small ($\sim 10^{-3}$) and difficult to detect. It is suggested that the alternative procedure may be adopted for studying the time dependence of the μ meson capture events rather than decay events. The capture rates should give rise to an effect of order ~ 1 . (T.F.H.)

29931 MEASUREMENTS OF MUON DISAPPEARANCE RATES vs TIME IN C, Mg, Al, Si, AND P. J. L. Lathrop, R. A. Lundy, V. L. Telegdi, R. Winston, and D. D. Yovanovitch (Univ. of Chicago). *Phys. Rev. Letters*, 7: 107-9 (Aug. 1, 1961).

It is noted that a negative curvature (K), in the meson (μ) disappearance rate from μ -mesic atoms as a function of time, is evidence for the existence of a hfs effect in the capture of μ mesons by nuclei. The disappearance rates are examined for Mg and Al, and it is found that, to the limits of experimental accuracy, $K = 0$. The μ meson lifetimes in C, Mg, Al, Si, and P are reported. (T.F.H.)

29932 SELF-CONSISTENT CALCULATION OF THE MASS AND WIDTH OF THE $J = 1$, $T = 1$, $\pi\pi$ RESONANCE. Fredrik Zachariasen (California Inst. of Tech., Pasadena). *Phys. Rev. Letters*, 7: 112-13 (Aug. 1, 1961).

The $J = T = 1$ π - π resonance is considered to result from the exchange of a single meson (ρ) between the two π mesons. A self-consistent calculation of the mass m_ρ and coupling constant γ for the ρ meson yields $m_\rho \approx 950$ Mev and $\gamma/4\pi \approx 2.8$. The calculation involves no parameters, such as π mass, etc. (T.F.H.)

29933 DIRECT DETERMINATION OF X-RAY REFLECTION PHASE RELATIONSHIPS THROUGH SIMULTANEOUS REFLECTION. M. Hart and A. R. Lang (Bristol Univ., Eng.). *Phys. Rev. Letters*, 7: 120-1 (Aug. 15, 1961).

Direct experimental determination of x-ray reflection phase relationships was accomplished through coherent dynamical interactions in simultaneous x-ray reflection. A diagram of the diffraction geometry for simultaneous reflection is given. (L.N.N.)

29934 NEGATIVE PION-PROTON ELASTIC SCATTERING AT 1.51, 2.01, AND 2.53 BeV/c OUTSIDE THE DIFFRACTION PEAK. Kwan W. Lai, Lawrence W. Jones, and Martin L. Perl (Univ. of Michigan, Ann Arbor). *Phys. Rev. Letters*, 7: 125-6 (Aug. 15, 1961).

Differential elastic scattering cross sections for negative π mesons on protons were measured for incident π^- momenta at 1.51, 2.01, and 2.53 BeV/c with emphasis on the angular region outside the diffraction peak. Behavior of the large angle differential elastic cross section was examined as a function of energy from the energy of the highest known resonance in the π^- -N system into the region in which the total cross sections appear to be approaching an asymptotic value. (L.N.N.)

29935 TOTAL CROSS SECTIONS FOR PIONS ON PROTONS IN THE MOMENTUM RANGE 4.5 TO 10 GeV/c. G. von Dardel, R. Mermod, P. A. Piroué, M. Vivargent, G. Weber, and K. Winter (CERN, Geneva). *Phys. Rev. Letters*, 7: 127-9 (Aug. 15, 1961).

Effects of μ meson contamination were eliminated in measurements of (π^\pm, p) total cross sections at 4.5 to 10 BeV/c. An apparatus diagram and graphical and tabular representations of data are given. (L.N.N.)

29936 MAGNETIC MOMENT OF POSITIVE AND NEGATIVE MUONS. D. P. Hutchinson (Columbia Univ., New York), J. Menes, G. Shapiro, A. M. Patlach, and S. Penman. *Phys. Rev. Letters*, 7: 129-33 (Aug. 15, 1961).

Techniques for measuring μ meson magnetic moments were refined and applied to positive and (bound) negative muons in materials. An apparatus diagram and tabular and graphical representations of data are given. Statistical accuracy of several parts per million is permitted in reasonably short runs, and the observation of environmental effects is made possible through increased sensitivity. (L.N.N.)

29937 THEORETICAL VALUES FOR MAGNETIC MOMENTS OF μ -MESONIC ATOMS. Kenneth W. Ford (Brandeis Univ., Waltham, Mass.), Vernon W. Hughes, and John G. Wills. *Phys. Rev. Letters*, 7: 134-5 (Aug. 15, 1961).

Theoretical calculations of the magnetic moments of μ -mesic atoms are outlined. Significant corrections for elements measured experimentally are presented in tabular form. (L.N.N.)

29938 EXAMPLE OF THE DECAY $\Lambda^0 \rightarrow p + \mu^- + \bar{\nu}$. F. Eisler, J. M. Gaillard, J. Keren, M. Schwartz, and

S. Wolf (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 7: 136-7 (Aug. 15, 1961).

The decay $\Lambda^0 \rightarrow p + \mu^- + \bar{\nu}$ was found in an exposure taken in the 20 inch BNL hydrogen bubble chamber. The theoretically predicted rate was 2.4×10^{-3} . A photodiagram and a table of data are given. (L.N.N.)

29939 CHARGE ASYMMETRIES IN THE ANGULAR DISTRIBUTION OF π AND K MESONS FROM ANTIPROTON ANNIHILATIONS IN FLIGHT. B. C. Maglić, G. R. Kalbfleisch, and M. L. Stevenson (Univ. of California, Berkeley). Phys. Rev. Letters, 7: 137-41 (Aug. 15, 1961). (UCRL-9670)

A difference in the angular distributions of positive and negative π and K mesons produced in $\bar{p}p$ annihilations was sought for the center of mass momentum 657 ± 16 Mev/c (1.6 BeV/c in the lab). The analysis was done on two samples of events: 1620 events of the type $\bar{p} + p \rightarrow n\pi$ with $n = 4$ to 8 and 287 events of the type $\bar{p} + p \rightarrow \bar{K} + K + n\pi$, $n = 1$ to 4 and at least one of the K mesons was observed to decay in the chamber. These events were observed inside a central volume of a 72-inch bubble chamber. The average antiproton momentum at the point of interaction was 1.61 ± 0.04 BeV/c (925 MeV kinetic energy) for the first sample mentioned and for 86% of the second. The remainder of the second sample was at 1.99 ± 0.05 BeV/c. The angular distribution obtained indicates a possibility that two different annihilation mechanisms are operative: the statistical one, which is dominant and produces an isotropic angular distribution; and a dynamical mechanism. (L.N.N.)

29940 STRUCTURE OF THE PROTON AND NEUTRON. R. M. Littauer, H. F. Schopper, and R. R. Wilson (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 7: 144-7 (Aug. 15, 1961).

Form factors of protons and neutrons are analyzed in the light of new measurements [Phys. Rev. Letters 7, 141 (1961)]. It is found necessary to attribute a magnetic moment of negative sign to the charge core that previous measurement [Phys. Rev. Letters 6, 286 (1961)] had revealed. (L.N.N.)

29941 EVIDENCE FOR A $T = 0$ THREE-PION RESONANCE. B. C. Maglic, L. W. Alvarez, A. H. Rosenfeld, and M. L. Stevenson (Univ. of California, Berkeley). Phys. Rev. Letters, 7: 178-82 (Sept. 1, 1961). (UCRL-9810)

A search was made for a $T = 0$ 3π resonance in the mass region $m_\omega > 3m_\pi$, where the decay $\omega \rightarrow \pi^+ + \pi^- + \pi^0$ is possible. The reaction $\bar{p} + p \rightarrow \pi^+ + \pi^+ + \pi^- + \pi^- + \pi^0$ was studied by measuring 2500 four-prong events produced by antiprotons of 1.61 BeV/c in the 72-in. bubble chamber. Tabular and graphical data are presented that fit the qualitative criteria for an axial vector matrix element (ω meson). There is reasonable evidence against both the A and PS mesons. (L.N.N.)

29942 TOTAL CROSS-SECTION MEASUREMENTS OF K^+p AND K^+n INTERACTIONS IN THE MOMENTUM REGION 0.77 TO 2.83 BeV/c. V. Cook, D. Keefe, L. T. Kerth, P. G. Murphy, W. A. Wenzel, and T. F. Zipf (Univ. of California, Berkeley). Phys. Rev. Letters, 7: 182-4 (Sept. 1, 1961). (UCRL-9732)

The discrepancy in the K^+p cross section σ_p , that of obtaining $\sigma_p = 12.9 \pm 1.0$ mb at 2.4 BeV/c and 24.5 ± 2.5 mb at 2.9 BeV/c, is explained. Graphical and tabular data and corrections are given, and a diagram of the apparatus is presented. (L.N.N.)

29943 ANTIPROTON-PROTON AND PROTON-PROTON TOTAL CROSS SECTIONS FROM 4 TO 20 BeV/c.

S. J. Lindenbaum, W. A. Love, J. A. Niederer, S. Ozaki, J. J. Russell, and L. C. L. Yuan (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 7: 185-8 (Sept. 1961).

Using the Brookhaven 33-BeV alternating gradient synchrotron, the $\bar{p}p$ and pp total cross sections at ~ 1 BeV/c intervals were determined between 4 and 20.3 BeV/c. Pomeranchuk's theorem (NSA:12-10028) is not verified for this range. (L.N.N.)

29944 K^+p INTERACTION AT 455 MeV. Theodore F. Stubbs (Univ. of California, Berkeley), Hugh Bradner, William Chinowsky, Gerson Goldhaber, Salamith Goldhaber, William Slater, Donald M. Stork, and Harold K. Ticho. Phys. Rev. Letters, 7: 188-92 (Sept. 1, 1961). (UCRL-9745)

Results obtained in studies of elastic and inelastic K^+p interaction at 455 MeV are presented. Tables are included that show the phase shifts for K^+N scattering in the $T = 1$ state and the modes of π production. A mass resolution curve and a differential cross section plot are also included. (L.N.N.)

29945 $\pi\pi$ RESONANCE IN π^-p INTERACTIONS AT 1.25 BeV. E. Pickup, D. K. Robinson, and E. O. Salant (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 7: 192-5 (Sept. 1, 1961).

Using the bubble chamber technique, 4000 π^-p events at 1.25 BeV incident pion energy were measured. 968 events of the type $\pi^- + p \rightarrow \pi^- + \pi^+ + n$, and 566 of the type $\pi^- + p \rightarrow \pi^- + \pi^0 + p$ were identified using the GUTS kinematic fitting program and ionization density measurements. Strong evidence was obtained for a $\pi\pi$ resonance in an $I = 1$ state. (L.N.N.)

29946 ONE-PION EXCHANGE IN $p-p$ COLLISIONS AT 2 BeV. W. J. Fickinger (Yale Univ., New Haven and Brookhaven National Lab., Upton, N. Y.), E. Pickup, D. K. Robinson, and E. O. Salant. Phys. Rev. Letters, 7: 196-8 (Sept. 1, 1961).

Proton interactions at 2 BeV were observed at the cosmotron in the 20-in. hydrogen bubble chamber. From the measurement of about 4000 two-prong events, 1300 events of the type $p + p \rightarrow p + n + \pi^+$ were identified, using digitalized equipment and the GUTS kinematic fitting program, together with ionization density measurements. In comparing the results with the theory of Selleri (NSA:15-9719), general agreement prevails but with significant deviations. (L.N.N.)

29947 K_{e3} DECAY AS A TEST OF UNIVERSAL V-A LEPTON COUPLING. M. Bolsterli and D. A. Geffen (Univ. of Minnesota, Minneapolis). Phys. Rev. Letters, 7: 203-4 (Sept. 1, 1961).

It is shown that the experimental spectrum of electrons from K_{e3} decay provides a direct test of universal vector-axial vector lepton coupling. The test is independent of the $K\pi$ form factor. Methods of treating the data so as to obtain information about the form factor itself are discussed. (L.N.N.)

29948 POSSIBLE EXPLANATION OF THE HIGHER PION-NUCLEON AND K^+p RESONANCES IN TERMS OF INELASTIC THRESHOLDS. James S. Ball and William Frazer (Univ. of California, San Diego and La Jolla). Phys. Rev. Letters, 7: 204-7 (Sept. 1, 1961).

It was found by means of partial-wave dispersion relations that a large, rapidly rising inelastic cross section can account for a sharp peak in the elastic scattering. The inelastic contribution to the higher partial waves was calculated, the principal mechanism being the production of the

29959 NEUTRAL K-MESONS. L. M. Lederman
(Columbia Univ., New York). *Rend. Scuola intern. fis.*

"Enrico Fermi," Corso XI (1959), 365-73(1960). (In English)

The properties (lifetime, decay modes, strangeness) of K_1^0 and K_2^0 mesons are studied. Theory predicts and experiment verifies that $K_1^0 \rightarrow \pi^+ + \pi^-$, with $PC = 1$ and lifetime $\tau_1 = 1 \times 10^{-10}$ sec; and that $K_2^0 \rightarrow 2\pi$ but may $\rightarrow 3\pi$, with $PC = -1$ and $\tau_2 \gg \tau_1$. The mass difference between K_1^0 and K_2^0 is found to be $< 10\hbar/\tau_1$. Measurements indicate that $\tau_2 = 8.1 \times 10^{-9}$ sec, and that no K_2^0 decays result in 2 or fewer products. (T.F.H.)

29960 μ -MESON CAPTURE AND DECAY. J. Steinberger (Columbia Univ., New York). Rend. Scuola intern. fis. "Enrico Fermi," Corso XI (1959), 375-91(1960). (In English)

Assuming that μ meson capture proceeds by the reaction $\mu^- + p \rightarrow n + \nu$, the angular correlations and polarizations of the recoil neutrons in Mg, C, and H are studied. The effects of the final energy level of the capturing nucleus are examined. The experimental capture and decay results are compared with the predictions of the V-A theory. A study is made of the products ($\pi^0 + n$) or ($\gamma + n$) from the π^-p interaction. Analysis of the electron pairs produced by γ internal conversion and π^0 decay yields information as to the π^0 parity and mass. (T.F.H.)

29961 ELECTROMAGNETIC PROPERTIES OF ELECTRONS AND MUONS. L. M. Lederman (Columbia Univ., New York). Rend. Scuola intern. fis. "Enrico Fermi," Corso XI (1959), 392-402(1960). (In English)

The theoretical and experimental electromagnetic properties of μ mesons and electrons are compared, in order to find some basis for comparison between these two types of particles. The electric and magnetic dipole moments and the g factors of the particles are studied. An experiment is suggested for accurately determining the μ meson g factor. (T.F.H.)

29962 ON THE MUON g -FACTOR. A. Petermann (CERN, Geneva). Rend. Scuola intern. fis. "Enrico Fermi," Corso XI (1959), 403-6(1960). (In English)

Experimental and theoretical determinations of the g factor of the μ meson are compared. The theoretical value is 2(1.00116), and the experimental value differs from this value by 0.008%. It is noted that increases in the accuracy in the measurements of the μ mass and resonant frequency might decrease the observed error to a negligible amount. The effects on g of a length Λ , inside which quantum electrodynamics is invalid, are discussed. (T.F.H.)

29963 PRODUCTION AND DETECTION OF AN ACCELERATED BEAM OF COMPLETELY POLARIZED DEUTERONS. C. W. Drake, D. C. Bonar, R. D. Headrick, and V. W. Hughes (Yale Univ., New Haven). Rev. Sci. Instr., 32: 995-6(Aug. 1961).

An accelerated beam of completely polarized deuterons was obtained with an apparatus consisting of a deuterium atom source, an atomic beam magnetic resonance system, an electron bombardment ionizer, and a 150 kv electrostatic accelerator. A description of each is given, and a schematic diagram of the apparatus is presented. (L.N.N.)

29964 A REMARK ON AN EXPERIMENTAL METHOD TO DETECT THE p -RESONANCE IN π - π SCATTERING PROCESS. Kuang-chao Chou and Tso-hsiu Ho (Joint Inst. for Nuclear Research, Dubna, USSR). Sci. Sinica (Peking), 10: 424-5(Aug. 1961). (In English)

It is suggested that the p -resonance in π - π scattering processes be experimentally investigated on the basis of the reactions $\pi^+ + \text{He}^4 \rightarrow \text{He}^4 + \pi^+ + \pi^0$, $\pi^+ + d \rightarrow d + \pi^+ + \pi^0$,

and $p + p \rightarrow d + \pi^+ + \pi^0$. All these processes have the property that the initial state particles are in the isotopic spin state $I = 1$, and the final state contains a nucleus of isotopic spin zero together with two π mesons. (L.N.N.)

29965 THE THEORY OF X-RAY SCATTERING BY MOSAIC CRYSTALS. A. V. Kuznetsov and Yu. S. Terminasov (Petrozavodsk State Univ., USSR). Soviet Phys.-Cryst., 6: 141-6(Sept.-Oct. 1961).

The relationship between the sizes of regions of coherent scattering and mosaic blocks is studied by the method of Laue summation in reciprocal space. The coherence condition is obtained. It is shown that the mosaic blocks lying in various columns do not interfere with one another. A general relationship is obtained between the size of the coherent scattering region and the size of the mosaic blocks, their number, and disorientation. Several special cases are analyzed. (auth)

29966 SOME CONSEQUENCES OF THE EXISTENCE OF π' -MESON-ISOTOPIC SINGLET. S. G. Matinyan. Trudy Inst. Fiz. Akad. Nauk Gruzin. S.S.R., 7: 37-42(1960). (In Russian)

The effect of the existence of a hypothetical π' meson-isotopic singlet on the branching ratios of K meson and hyperon decays is considered on the basis of the $|\Delta T| = \frac{1}{2}$ selection rule. (auth)

29967 ON COMPOUND MODEL OF ELEMENTARY PARTICLES. M. E. Perlman. Trudy Inst. Fiz. Akad. Nauk Gruzin. S.S.R., 7: 43-57(1960). (In Russian)

The formulas for compound particles in various models are discussed. It is shown that if one takes Pauli's principle for the system $N-\bar{N}$, the spin of the isosinglet π' meson may be equal only to 1, and π' is very probably a vector meson. The equation for Green's function is derived for compound mesons, then it is developed into a Duffin-Kemmer mass-operator equation for compound mesons. The estimate of masses shows the π' mass is of the order of K -meson mass. It is pointed out that Schwinger's assumption of the nature of μ -meson mass does not agree with the experimental data on the magnetic moment. A rough estimate of the π' - N coupling constant gives the value $g'^2/4\pi \approx 6.5$. (auth)

29968 ON ENERGY LOSS OF HEAVY PARTICLES. N. M. Polievktov-Nikoladze. Trudy Inst. Fiz. Akad. Nauk Gruzin. S.S.R., 7: 135-46(1960). (In Russian)

The energy loss of heavy particles can be calculated qualitatively by means of Maxwell's quasi-macroscopic equations. Amplitudes $\epsilon(\vec{k}, w)$ of inelastic scattering depending both on the frequency and on the wave vector \vec{k} (spatial dispersion) are used instead of the dielectric constant $\epsilon(w)$ depending on the frequency w . The effective dielectric constant for a slightly condensed substance is determined. Maxwell's quasi-macroscopic equations may be introduced because the recoil is neglected. The equations are the consequence of general conservation laws of charge and gauge invariance. The general separation of losses into ionization and Cherenkov losses is given. This separation is based on the different physical sense of the poles of the effective Green's function. It is shown that because of spatial dispersion, Maxwell's quasi-macroscopic equations are quantitatively true not only for the macroscopic values of the impact parameter but for its microscopic values as well, when ordinary macroscopic equations become meaningless because of the neglect of spatial dispersion. (auth)

29969 LIFETIME OF Λ^0 -HYPERONS GENERATED BY COSMIC RAYS. G. E. Chikovani. Trudy Inst. Fiz. Akad. Nauk Gruzin. S.S.R., 7: 147-86(1960). (In Russian)

It was found that $\tau_{\Lambda^0} = (3.02^{+1.4}_{-1.1}) \times 10^{-10}$ sec. Analysis of earlier investigations shows an average weighted value of $(3.10^{+0.48}_{-0.37}) \times 10^{-10}$ sec, this value does not contradict the data obtained. (auth)

29970 ON ANGULAR DISTRIBUTION OF DECAY PRODUCTS OF Λ^0 -HYPERONS. Z. Sh. Mandzhavidze, N. N. Roinishvili, and G. E. Chikovani. Trudy Inst. Fiz. Akad. Nauk Gruzin. S.S.R., 7: 193-5(1960). (In Russian)

The angular distribution of decay protons relative to the line of flight of Λ^0 hyperons generated in a lead target by cosmic rays was studied and the results are given. Only Λ^0 hyperons with momentum less than 800 Mev/c were considered. The asymmetry coefficient for 24 Λ^0 hyperons in this range of momenta is $\alpha\bar{P} = -0.59 \pm 0.28$. (auth)

29971 ENERGY DISTRIBUTION OF STRANGE PARTICLES. Z. Sh. Mandzhavidze and N. N. Roinishvili. Trudy Inst. Fiz. Akad. Nauk Gruzin. S.S.R., 7: 197-200 (1960). (In Russian)

The energy distributions of Λ^0 , Θ^0 , and Σ^+ particles generated in a lead target by cosmic particles are described. The observed spectra agree with the previously noticed sharp decrease of the number of Λ^0 hyperons with the increase of energy and gentle sloping of the spectrum of Θ^0 mesons. The distribution of Σ^+ hyperons according to their energies repeats the spectrum of Λ^0 particles. This probably shows the sharply anisotropic angular distribution of Λ^0 and Σ^+ in the C-system of production and can possibly be interpreted as a common property of the generating process of different types of barions. (auth)

29972 ON THE GÜRSEY TYPE EQUATION FOR BARYONS. M. N. Kyiv (Koiv). Trudy Inst. Fiz. i Astron., Akad. Nauk Eston. S.S.R., No. 13, 67-78(1961). (In Russian)

The Gürsey type equation for describing all baryons is considered. Transformations which are isomorphic to Tiomno and Polkinghorne-Salam isotopic groups are obtained. (auth)

29973 ON DISTINGUISHING MASSES OF NUCLEONS. M. N. Kyiv (Koiv). Trudy Inst. Fiz. i Astron., Akad. Nauk Eston. S.S.R., No. 13, 79-86(1961). (In Russian)

The well known Gürsey equation for nucleons with distinct masses is considered. The new equation is not invariant under Pauli transformation. (auth)

29974 WEAK INTERACTION DECAY OF BARYONS. Kh. Kh. Yiglane (H. Oiglane). Trudy Inst. Fiz. i Astron., Akad. Nauk Eston. S.S.R., No. 13, 87-111(1961). (In Russian)

All known 8 baryons (nucleon, Ξ hyperons, Σ hyperons and Λ hyperon) are assumed to form a set of particles which can be described by a 32-component spinor equation. The 10-dimensional vector space corresponding to the 32 dimensional spinor space consists of the sum of two subspaces: a 4-dimensional space-time and a 6-dimensional isotopic space. The 3-component isotopic spin vectors are constructed by means of inversion operations in the isotopic space. The wave equation for free baryons is solved by a perturbation procedure. The Hamiltonian of the "nonperturbed problem," H_0 , is found by demanding its commutation with the spin projection operator S and with operators $\Gamma_k J^{R(3)}$, $k = 1, 2, 3$ whose eigenvalues represent quantum numbers of the isotopic spin, t_k . Solution of the equations of the "nonperturbed problem" provides a classification of baryons. Such a solution coincides essentially with that

given by Tiomno. The perturbation Hamiltonians describing weak interaction transitions between baryons are discussed, and quasiempirical equation for baryons in an external electromagnetic field is proposed. This equation turns out to be non-invariant in respect to the charge conjugation transformation C_q . The behavior of Hamiltonians is investigated under the transformations C_q , L_3 , and L_+ , where L_3 denotes the inversion operation of space co-ordinates and of basic vectors e^6 , e^8 , e^9 in the isotopic space, and L_+ corresponds to the inversion of time-coordinate and of basic vectors e^5 , e^7 , e^{10} in the isotopic space. The Hamiltonian of the nonperturbed problem is invariant under all these transformations. The perturbation Hamiltonians display more restricted invariance properties, being invariant under $C_q L_3$ and $C_q L_+$, respectively. (auth)

29975 ELECTRIC POLARIZATION OF DEUTERONS ARISING IN THE SCATTERING OF DEUTERONS BY A COULOMB FIELD. T. L. Abelishvili and O.(A.) G. Sitenko (Gor'kii Khar'kov State Univ., [USSR]). Ukrain. Fiz. Zhur., 6: 3-11(Jan.-Feb. 1961). (In Ukrainian)

The influence of electric polarization of deuterons arising in the scattering of deuterons by the Coulomb field of the nucleus is considered for the case when the energies of the incident deuterons are below the Coulomb barrier. The wave function of the deuteron ground state in the Coulomb field and the multipole polarization of the deuterons are determined in adiabatic approximation. The corrections of the cross section of elastic scattering due to multiple polarization of deuterons are found. Electric polarization in the (d,p) stripping reactions is considered. (auth)

29976 ELECTRON BEAM ON A COAXIAL HELICAL LINE. TAKING INTO CONSIDERATION THE GEOMETRICAL DIMENSIONS OF THE HELIX. B. V. Kondrat'ev (Gor'kii Khar'kov State Univ., [USSR]). Ukrain. Fiz. Zhur., 6: 77-85(Jan.-Feb. 1961). (In Ukrainian)

When the band width of the helix increases, the phase velocity increases and the amplitude decreases. The power flux and coupling resistance at high frequencies depend only slightly on the geometry of the helix. (auth)

29977 BLOCK EQUATION FOR TWO-PARTICLE BOND SYSTEM WITH 1/2 SPIN. N. N. Korst. Vestnik Moskov. Univ., Ser. III, 16: No. 1, 76-8(Jan.-Feb. 1961). (In Russian)

A system of interacting spins is analyzed by means of Bloch equations. The system is comprised of separate pairs of interacting spins with the quantum number $I = 1/2$. A mixture of water with some liquid without magnetic moment, or adsorbed water in the case of low surface saturation, are used as examples. Inside a water molecule the protons are bonded by dipole-dipole interaction while proton interactions of different molecules are neglected. The problem is reduced to a bond system of two identical particles with spin $I = 1/2$. (R.V.J.)

29978 POLARIZATION OF ELASTICALLY SCATTERED PARTICLES WITH SPIN 1. Yu. A. Popov. Vestnik Moskov. Univ., Ser. III, 16: No. 2, 26-33(Mar.-Apr. 1961). (In Russian)

Properties of longitudinally polarized particles with spin 1 in elastic scattering are investigated. The results are correlated with results obtained on fermions by A. A. Sokolov, et al., (Zhur. Eksptl'. i Teoret. Fiz. 38, 165, 1779, 1960). (R.V.J.)

29979 POLARIZATION CORRELATIONS IN γ -QUANTUM ELECTRON-POSITRON PAIR PRODUCTION. B. K. Kerimov and I. M. Nadzhafov. Vestnik Moskov.

Univ., Ser. III, 16: No. 2, 41-53 (Mar.-Apr. 1961). (In Russian)

The angular and energy distributions of longitudinally polarized electron-positron pairs produced by radially polarized γ quanta in a Coulomb nuclear field were investigated in Born approximation. The developed formulas are applied in studies of the pair production differential and integral cross sections as functions of the longitudinal polarization of the incident γ quantum and the produced pair. Expressions are found for the angular and energy dependence on the degree of longitudinal polarization of the produced pairs. Formulas are also given for relativistic electron bremsstrahlung emission cross section considering polarization correlations. (R.V.J.)

29980 BREMSSTRAHLUNG OF ELECTRONS IN THE FIELD OF NATURAL ATOMS. Hartmut Huber (Technische Hochschule, Munich). Z. Physik, 163: 382-400 (1961). (In German)

The process of deceleration of electrons by the field of neutral atoms is investigated by the aid of a model approximating the neutral atom by a constant potential U in the interior of a sphere of radius r . The free-free emission coefficient is determined in the general case for an isothermal plasma; in the special case of an impenetrable sphere it is compared with the emission coefficient of the ion bremsstrahlung as obtained by the "soft" approximation. The results show that electron-atom radiation may not be negligible as compared with electron-ion radiation, and this fact may be used to explain the experimentally observed increase of the emission coefficient with pressure which is more rapid than linear. This is verified numerically in the limiting case of an impenetrable sphere. In addition the bound-free absorption coefficient is determined both in the general and in the special case of the H^- ion; a comparison is made with the absorption coefficient as obtained by Chandrasekhar. By the aid of the method of "best approximation" given in the concluding part of the present paper the quantities U and r may be determined for any neutral atom. (auth)

29981 COHERENT TRANSIENT RADIATION OF CURRENT-CARRYING AND CHARGED CLOTS. V. N. Tsytoich. Zhur. Tekh. Fiz., 31: 923-35 (Aug. 1961). (In Russian)

It is shown that coherent transition radiation carries away the larger part of the electromagnetic mass if $\kappa_0 = (c/\omega_0)$ (where ω_0 is the Langmuir frequency) becomes comparable to the magnitude of the transverse cluster. The emission intensity as a function of linear cluster dimensions is analyzed. (tr-auth)

29982 INERTIA IN CURRENT INTERACTION. M. L. Levin and V. N. Tsytoich (Lebedev Inst. of Physics, Moscow). Zhur. Tekh. Fiz., 31: 936-8 (Aug. 1961). (In Russian)

Interactions of currents are analyzed under the assumption that the current value can reach magnitudes close to infinity when electrons become relativistic. (tr-auth)

29983 PARTICULES ELEMENTAIRES. FEUILLES D'INFORMATION. (Elementary Particles. Information Sheets). Monograph No. 4. Second Series, 1960. J. Geheniau, ed. Brussels Institut Interuniversitaire des Sciences Nucleaires, 1960. 146p.

The important data relative to elementary particles are assembled in loose-leaf form. The 1960 Information Sheets are composed of two new chapters and addenda to the 1959 Information Sheets. The first part on classification has not been modified, but the table of particle masses was refined

from values given at the Rochester Congress in 1960. The appendix to the chapter on pion-nucleon scattering is a presentation, with commentaries, of experimental data. Nucleon-nucleon scattering is treated critically with some depth. The Fermi Universal Interaction Law is treated briefly. (J.S.R.)

Neutron Physics

Refer also to abstract 29397

29984 (K-1486) NEUTRON ENERGY DEGRADATION BY WATER MODERATION. Hugh F. Henry and John R. Knight (Oak Ridge Gaseous Diffusion Plant, Tenn.). Sept. 27, 1961. Contract W-7405-eng-26. 31p.

Activations of cadmium-covered indium, gold, and manganese foils placed at various depths in water and plastic moderators were interpreted in terms of a slowing down curve to give an indication of the relative neutron spectrum incident upon the moderator surface. The neutron sources used were Godiva, the Tower Shielding Reactor, and moderated uranium materials at different U^{235} enrichments. The results were compared with a Godiva spectrum as determined otherwise and with the fission spectrum. The general shape of the spectrum curve determined was similar to the comparative ones, although there were apparently more neutrons at the higher energies than were found otherwise or were predicted theoretically. At least part of the discrepancy was determined as being due to scatter from the surroundings, and it was concluded that this method of spectrum indication for energies above about 1 Mev would be possible only where the detecting system was well-shielded. Other possible factors causing the apparent discrepancy are discussed. (auth)

29985 (WAPD-TM-284) GRAPHS OF COEFFICIENTS FOR DETERMINING MULTIGROUP P-1 CONSTANTS FROM DIFFERENTIAL SCATTERING CROSS SECTIONS. H. J. Amster and C. B. Noll (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). July 1961. Contract AT-11-1-GEN-14. 11p.

Parameters used in the age and generalized Greuling-Goertzel theories for the slowing down of neutrons can be expressed in terms of various linear combinations of all the Legendre components of the elastic scattering cross sections. Graphs of the coefficients required in P-1 flux approximations are plotted as functions of moderator mass number. The curves demonstrate the utility of order-of-magnitude estimates previously made in heavy moderator approximation consistency arguments. (auth)

29986 (UCRL-Trans-705) NEUTRON GENERATORS. V. I. Strikzhak (Strijak) and N. S. Nazarov. Translated by Richard B. Crawford (Univ. of California Lawrence Radiation Lab., Berkeley) from Pribery i Tekh. Ekspt., 6: No. 2, 72-5 (1961). 10p.

Descriptions are given of four types of neutron generators based on $D(d,n)He^3$ and $D(t,n)He^4$ reactions at low accelerating potentials (up to 200 kv). Construction details of ion sources, accelerating tubes, and auxiliary devices are given. High-frequency ion sources and glow discharge sources in magnetic fields produce high ion currents at the target. The maximum neutron yield (as compared with a standard Ra- α -Be source) in reaction $D(d,n)He^3$ is 2×10^8 /sec and in reaction $D(t,n)He^4$ it is $\sim 10^{10}$ /sec. (tr-auth)

29987 MEASUREMENT OF THERMAL NEUTRON DIFFUSION PARAMETERS IN WATER AND IN SOLID

DIPHENYL WITH PULSED NEUTRON SOURCE. A. Ádám, L. Bod, and L. Pál (Central Research Inst. for Physics, Budapest). *Acta Phys. Acad. Sci. Hung.*, 13: 25-33(1961). (In English)

The diffusion parameters of thermal neutrons were measured in water and in solid diphenyl at room temperature by the pulse method. The results of the measurements in water are consistent within the statistical error with the values known in literature. The diffusion parameters obtained in diphenyl are: $l_0 = 286 \pm 23 \mu \text{ sec}$, $D(T_0) = 42940 \pm 1800 \text{ cm}^2 \text{ sec}^{-1}$, $L_D = 3.50 \pm 0.18 \text{ cm}$, $C = 13300 \pm 2850 \text{ cm}^4 \text{ sec}^{-1}$ and $\lambda_t = 0.515 \text{ cm}$. (auth)

29988 ON THE POSSIBILITY OF MEASURING POLARIZATION IN THE SCATTERING OF A NEUTRON BY A NEUTRON. O.(A.) G. Sitenko and V. F. Kharchenko (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR and Gor'kii Khar'kov State Univ., [USSR]). *Ukrain. Fiz. Zhur.*, 6: 20-4(Jan.-Feb. 1961). (In Ukrainian)

The method of Chew and Low was applied to consider the possibility of determining the polarization and the correlation tensor of polarization in the interaction of a neutron with a neutron by means of an analysis of the reaction of the splitting of a deuteron by a neutron. Indications are given as to the necessary experiments for this reaction, by means of which the scattering matrix of a neutron may be restored. (auth)

29989 MEASUREMENT OF THE DIFFERENTIAL CROSS SECTIONS AND THE MEAN LOGARITHMIC ENERGY LOSS IN THE SCATTERING OF SLOW NEUTRONS ON WATER AND ICE. Christian Reinsch (Technische Hochschule, Munich). *Z. Physik*, 163: 424-34(1961). (In German)

Neutrons with energies from 0.039 and 0.078 eV were scattered on thin layers of water and ice at different temperatures. For the production of monoenergetic neutrons, a simple crystal spectrometer, which was placed at the P3 irradiation channel of the FRM, was used. The angular distribution of the scattering neutrons was determined with a Li^6I scintillation counter with a detection sensitivity of approximately 100%, and from that the differential scattering cross section $d\sigma/d\Omega$ was calculated. There was only a slight variation between water and ice; it originated principally in the contribution of the coherent scattering in ice, which disappears in water. From transmission experiments with silver filters, an expression for the mean logarithmic energy loss ξ per collision was obtained. A comparison with the theory of Nelkin gives good agreement with respect to $\cos\theta$, but a certain deviation with respect to ξ . These probably result from the assumption of a single frequency for the torsion oscillations of the H_2O molecule. Theoretical curves for $d\sigma/d\Omega$ are still not under consideration at present. (tr-auth)

Nuclear Properties and Reactions

29990 (AERE-NP/R-2033) THE $n,2n$ CROSS-SECTIONS OF U^{238} AND Th^{232} FOR 14 MEV NEUTRONS. J. A. Phillips (United Kingdom Atomic Energy Authority, Research Group, Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 8, 1956. 13p.

The $n,2n$ cross-sections of U^{238} and Th^{232} were determined for 14-Mev neutrons. Gram quantities of these isotopes were irradiated in a known 14-Mev neutron flux until sufficient activation was produced. The amounts of U^{237} and Th^{231} formed were measured by counting low energy γ -rays emitted by these isotopes using Xe- and Kr-filled proportional counters. During this work, a γ -ray from the

decay of Th^{231} was found at $25.6 \pm 0.1 \text{ kev}$, this γ having been previously reported at 22 kev. The intensity of this γ , and the type of transition giving rise to it, were determined. (auth)

29991 (AFOSR-539) INVESTIGATION OF GAMMA RADIATION FROM NUCLEAR REACTIONS. Final Report January 1-December 31, 1960. K. G. Malmfors (Sweden. Kungliga Vetenskapsakademien. Nobelinstitutet för Fysik, Stockholm). Mar. 14, 1961. Contract AF61(052)-336. 10p.

An investigation was made of gamma radiation from nuclear reactions by means of a time-of-flight spectrometer. The reaction $\text{F}^{18}(\text{p},\alpha)\text{O}^{16}$ was studied. A thick target of CF_2 was bombarded with 3.5-Mev protons and the resulting gamma radiation was allowed to fall on a converter at a distance of 5 cm from the target. An aluminum converter was used and the Compton electrons were analyzed according to the flight time in the spectrometer. Electronic equipment was constructed which made it possible to also use the instrument as a pair spectrometer. Three gamma lines with energies of 6.14, 6.92, and 7.12 Mev were observed. The resolution of the instrument was about 2.5%. (auth)

29992 (APEX-604) SUPPLEMENT 3 TO APEX-515, "CROSS SECTIONS FOR REACTOR ANALYSIS." Mary S. Ferry and Jacob W. Zwick (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Apr. 3, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 33p.

Seventeen new records were added to the Nuclear Data Tape for 19 levels. The new cross sections are for rhodium, platinum, and tantalum. Other additions are for cross section mixtures and for europium which has been corrected for resonance self-shielding. (D.L.C.)

29993 (APEX-626) CALCULATION OF THERMAL AVERAGE CROSS SECTIONS. J. R. Terrall and A. H. Barnett (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). June 1959. Contracts AF33(600)-38062 and AT(11-1)-171. 34p.

The calculation of thermal average cross sections by means of Maxwellian averages is presented. Even though the neutron distribution at low energies may not be exactly Maxwellian in form, the spectrum can often be usefully represented as Maxwellian plus corrections. A numerical integration scheme is proposed for calculation of the Maxwellian average of cross sections that do not vary as the reciprocal of neutron velocity. Other cases can be analytically integrated. An IBM 704 program for computing these averages is described. A similar report was written in 1955. Since that time, however, the integration scheme and the machine program have been revised for greater flexibility and accuracy. (auth)

29994 (BAW-1223) U-238 RESONANCE INTEGRAL EXPERIMENT. Interim Report, February 1, 1961 to June 30, 1961. W. G. Pettus and C. Samuel (Babcock and Wilcox Co. Critical Experiment Lab., Lynchburg, Va.). July 31, 1961. Contract AT(30-1)-2578. 14p.

Progress is reported on an investigation of the resonance absorption properties of U^{238} . The investigation includes determinations of: the resonance integrals of U^{238} and U^{238}O_2 as a function of sample diameter; the temperature coefficients of the resonance integrals of these materials; and the Dancoff effect in square lattices of U^{238}O_2 pins. The planning and design stages, as well as the apparatus development and construction phases, are completed. The apparatus (fuel elements, temperature stabilizer, oscillator, etc.) developed for the various measurements is described. (T.F.H.)

29995 (DEG-Report-351) THE ACTIVITY OF IRRADIATED URANIUM FUEL SPECIMENS AT TIMES GREATER THAN 10 HOURS AFTER IRRADIATION. I. S. McGill (United Kingdom Atomic Energy Authority. Development and Engineering Group, Dounreay, Caithness, Scotland). Feb. 27, 1961. 10p.

Graphs and tabulated data are provided which allow determination of the β -particle and γ -ray activity in irradiated uranium fuel specimens at any time greater than 10 hours after irradiation, provided the operating power rating of the specimen and the total irradiation time are known. The latest available information on fission product yield and decay γ yields was employed and a suitable grouping of decay products was chosen to allow rapid evaluation of the energy release for a wide range of irradiation conditions. The γ -ray energy was evaluated for seven energy groups from 0 to 3 Mev. (auth)

29996 (GA-2113) ENERGY-DEPENDENT AND SPECTRUM-AVERAGED THERMAL CROSS SECTIONS FOR THE HEAVY ELEMENTS AND FISSION PRODUCTS FOR VARIOUS TEMPERATURES AND C:U²³⁵ ATOM RATIOS. N. F. Wikner and S. Jaye (General Atomic Div., General Dynamics Corp., San Diego, Calif.). June 16, 1961. Contract AT(04-3)-314. 148p.

Energy-dependent point cross sections were recorded over the range from 0.005 to 2.5 ev for the heavy elements Th, U²³³, U²³⁴, U²³⁵, U²³⁶, Np²³⁹, Pu²³⁹, Pu²⁴⁰, Pu²⁴¹, and Pu²⁴²; for the specific fission products Mo⁹⁵, Tc⁹⁹, Rh¹⁰³, Cd¹¹³, Xe¹³¹, Xe¹³⁵, Cs¹³³, Cs¹³⁵, Nd¹⁴³, Nd¹⁴⁵, Pm¹⁴⁷, Sm¹⁴⁹, Sm¹⁵¹, Sm¹⁵², Eu¹⁵³, Gd¹⁵⁵, and Gd¹⁵⁷; and for the fission-product aggregates for U²³³, U²³⁵, and Pu²³⁹. The point cross sections are given in a form suitable for use with General Atomic's thermalization codes. Examples of thermal spectra and associated average cross sections were recorded for C:U²³⁵ atom ratios of 2,819, 5,000, 7,500, and 10,000 for various graphite temperatures. (auth)

29997 (JINR-P-374) MATERIALY KONFERENTSIU PO YADERNYM REAKTSIYAM S MNOGOZARYADNYMI IONAMI, MART 1958. (Pravlenaya Stenogramma). (Papers of the Conference on Nuclear Reactions with Multi-charged Ions, March 1958. (Corrected Stenographic Account)). (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1959. 227p.

Eighteen papers are included. Representatives of Bulgaria, Hungary, GDR, China, Mongolia, Poland, Rumania, Czechoslovakia and USSR participated in the conference. The problems of nuclear reactions with heavy ions and some problems of nuclear chemistry are discussed as well as the design of a cyclotron and the performance of multicharged ion sources. (R.V.J.)

29998 (NP-10570) A STUDY OF THE RESONANCE INTEGRAL OF ZIRCONIUM. E. Hellstrand, G. Lindahl, and G. Lundgren (Aktiebolaget Atomenergi, Stockholm). June 1961. 5p. (EANDC (OR) 15).

Issued by European-American Nuclear Data Committee.

An investigation was carried out to determine the effective resonance integral of zirconium for different sample thicknesses. As it was not possible to obtain reactor-grade zirconium samples of suitable geometrical form, the measurements were made on Zircaloy-2 of known composition. Results are presented in tabular and graph form. An extrapolation to zero plate thickness yielded a value of 0.85 ± 0.15 b. (M.C.G.)

29999 (NP-10683) INTERPRETATION OF GAMMA-GAMMA DIRECTIONAL CORRELATIONS INVOLVING DIPOLE-QUADRUPOLE MIXTURES. R. G. Arns and

M. L. Wiedenbeck (Michigan. Univ., Ann Arbor). [nd]. 35p.

A collection of curves is presented to provide a method for interpreting γ - γ directional correlations when one or both gamma rays involve a mixture of dipole and quadrupole radiation. (auth)

30000 (NP-10708) A STUDY OF THE Na²³(d,n)Mg²⁴ REACTION WITH NUCLEAR EMULSIONS. J. M. F. Jeronymo and E. Lerner (Rio de Janeiro. Centro Brasileiro de Pesquisas Fisicas). 1961. 25p. (Notas de Fisica, Vol. VII, No. 13).

Neutrons from the Na²³(d,n)Mg²⁴ reaction produced by 2-Mev deuterons were detected and their energies measured in nuclear emulsions by the proton recoil method. The energy and the Q-value spectra of neutrons emitted at 0, 5, 25, 35, 45, 60, and 85° to the deuteron beam are given. The ground state Q-value is found to be $Q_G = 9.56 \pm .12$ Mev, and excited levels are found at $E_i = 1.40 \pm .16$; $4.24 \pm .14$; $5.27 \pm .14$; $6.09 \pm .14$; $7.68 \pm .13$; and $8.63 \pm .13$ Mev. (auth)

30001 (NYO-2963) MEASUREMENTS OF THE SPINS OF Tm¹⁶⁶ AND Tm¹⁶⁷ AND THE HYPERFINE STRUCTURE OF Tm¹⁶⁶ BY THE ATOMIC BEAM MAGNETIC RESONANCE METHOD (thesis). James C. Walker (Princeton Univ., N. J. Palmer Physical Lab.). June 1961. Contract AT(30-1)-937. 97p.

The spins(I) are: $I = 1/2$ for Tm¹⁶⁷ and $I = 2$ for Tm¹⁶⁶. The hyperfine interaction constants for Tm¹⁶⁶ are: $|a| = 4 \pm 6$ Mc and $|b| = 8,600 \pm 450$ Mc with $b/a > 0$. Using these values of a and b , the following values are obtained for the nuclear magnetic dipole moment (μ_I) and electric quadrupole moment (Q) of Tm¹⁶⁶. $|\mu_I| = 0.010 \pm 0.016$ n. m. (for $Q/\mu_I < 0$), and $|Q| = 5.2 \pm 0.6 \times 10^{-24}$ cm². The value of μ_I agrees with odd-group model predictions. The value of Q seems much larger than that predicted by the distorted nucleus model. (auth)

30002 (TID-13494) STUDIES OF THE NATURAL RADIOACTIVITY OF RHENIUM (thesis). Henry Kocol (Purdue Univ., Lafayette, Ind.). Jan. 1961. Contract AT(11-1)-694. 33p.

A description is given of work conducted to obtain the beta spectra and the half life of rhenium-187 using rhenium trioxychloride as the compound to be counted. When proportional counting was used, no beta spectra could be obtained because of the effectiveness of rhenium trioxychloride as a counter poison. Calculations show that the probability of electron capture per collision with rhenium trioxychloride in P-10 gas (90% argon, 10% methane) is 0.09 while that in methane is 0.2. Geiger counting with rhenium trioxychloride in a large anode counter was successful only once, from which the half life was determined as 7.9×10^{10} years. Later attempts at Geiger counting were unsuccessful because in the presence of rhenium trioxychloride the plateaus were short and steep and shifted continuously, disappearing completely after a time. (auth)

30003 (UCOL-P-507) THE LEVEL STRUCTURE OF Cr⁵². R. R. Wilson, A. A. Bartlett, J. J. Kraushaar, J. D. McCullen, and R. A. Ristinen (Colorado. Univ., Boulder). 1961. 58p.

The low excited states of Cr⁵² are investigated, by studying the decay of Mn⁵² with scintillation spectrometers and a double-focusing beta-ray spectrometer. In addition to three strong lines at 0.74, 0.94, and 1.43 Mev, a number of weak transitions are observed, which require the addition of level at 3.614 Mev, and which yield information on the spins and parities of the various levels. The following

gamma rays are observed: 1.434 Mev (100%), 1.332 Mev (5.7%), 1.246 Mev (5.8%), 1.214 Mev (2.9%), 0.935 Mev (83.9%), 0.847 Mev (2.6%), 0.744 Mev (81.9%), and 0.346 Mev (0.9%), in addition to several weaker and more uncertain lines. A decay scheme is constructed that consists of levels at 1.434 Mev (2+), 2.369 Mev (4+), 2.648 Mev, 2.766 Mev (4+), 3.112 Mev (6+), 3.161 Mev (1,2,3), 3.614 Mev (5+, 6+), and 3.832 Mev (5+, 6+). A comparison is made between the experimentally determined level structure and theoretical calculations. Mn^{54} is present in the Mn^{52} . The energy of the Mn^{54} gamma transition is determined to be 834.9 ± 1.1 kev. (auth)

30004 (UCRL-9753) THEORY OF ODD-MASS ELLIPSOIDAL NUCLEI (thesis). Lucy Wu Person (California Univ., Berkeley. Lawrence Radiation Lab.). July 1961. Contract W-7405-eng-48. 163p.

Theoretical calculations dealing with the low-lying vibrational and rotational spectra of deformed nuclei are presented. In the calculations, the rotational spectrum of an odd nucleon in an ellipsoidal well is studied for the $N = 2$ and $N = 4$ shells. Applying this method, the ground spins of the light cesium isotopes are explained. An evaluation is made of the rotational-energy spectrum, magnetic moment, and E2 reduced transition probabilities for Cs^{131} . Good agreement is obtained with gamma = 38 deg and beta = 0.29. The spins and parities of two levels for four nuclei, which probably belong to the γ -vibration band in the asymmetric limit (Lu^{175} , Ta^{181} , Re^{185} , and Re^{187}), are predicted. The ground-state magnetic moment for these nuclei was calculated. The agreement shows that asymmetry does not have a large effect on the magnetic moment of strongly deformed nuclei. (auth)

30005 (NP-tr-743) SCATTERING OF FAST NEUTRONS BY O^{16} . E. Baldinger, P. Huber, and W. G. Proctor. Translated by L. F. Secretan for U.K.A.E.A., Atomic Energy Research Establishment, Harwell, Berks, Eng. from *Helv. Phys. Acta*, 25: Nos. 1-2, 142-52(1952). 19p. (Includes original, 4p.).

The differential cross sections for the scattering of neutrons from O^{16} were measured at various energies between 2 and 4 Mev using an ionization chamber. These data, together with the known total cross section, permitted an analysis to be made for the partial wave phases responsible for the scattering. The analysis showed that four levels, with suitable potential scattering, are responsible for the observed total and differential cross sections. (auth)

30006 SOME PRACTICAL REMARKS CONCERNING THE CALCULATION OF THE PHASE SHIFTS OF THE YUKAWA POTENTIAL. T. Tietz (Univ. of Łódź, Poland). *Acta Phys. Acad. Sci. Hung.*, 13: 57-60(1961). (In English)

Some practical formulas are given making possible the calculation of the phase shifts of the Yukawa potential. The formulas depend on whether the radial quantum number l is large or small. Some numerical values illustrate the accuracy of the mentioned phase shifts. (auth)

30007 NEW RESULTS IN THE THEORY OF NON-AXIAL NUCLEI. A. S. Davydov (Moscow State Univ.). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 782-91 (July 1961). (In Russian)

If the shape of a nucleus is approximated by an ellipsoid, two parameters β ($0 < \beta$) and γ ($0 < \gamma < \pi/3$) will then determine the shape of the nucleus at constant volume. With the addition of the three Euler angles θ_1 , θ_2 and θ_3 , there are five dynamic variables which in the simplest model characterize the collective motions in even-even nuclei. Various

theories of the collective excitations of even-even nuclei with different types of approximation are reviewed. It is noted that the spectrum of rotational states becomes quite complex if it is assumed that the equilibrium shape of the nucleus does not have axial symmetry. This theory with an adiabatic approximation explains a number of experimental facts. The relative position of the levels and the probability of E2-transitions between the levels depends only on the single parameter γ which is determined from the ratio of the energies of two excited states with a spin of 2. However, rotation of the nucleus is associated with a change in internal state of the nucleus. The internal excitations are determined by the dynamic variables β and γ which can be expressed by two parameters: a parameter μ indicating the deviation from adiabatic conditions, and the parameter γ indicating the non-symmetry. These parameters can be determined if the energies of three excited states of the nucleus are known. The position of other excited states, the spins and probabilities of the electromagnetic transitions between the states, can be determined from values of μ and γ . The general case of quadrupole excitations of even-even nuclei is considered. Here all five quantities β , γ , θ_1 , θ_2 and θ_3 are considered as dynamic variables. Since the type of collective excitations of even-even nuclei depends on the shape of the nucleus in the ground state, the cases of a spherical nucleus ($\beta^0 = 0$) and of a non-spherical nucleus are considered separately. It is pointed out that the collective excitations of negative parity observed in even-even nuclei have not been analyzed yet, and that there is no quantitative theory for odd and odd-odd nuclei. (TTT)

30008 INVESTIGATION OF THE DECAY SCHEME OF Gd^{147} . A. A. Sorokin and K. P. Mitrofanov (Moscow State Univ.). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 799-807(July 1961). (In Russian)

The decay of Gd^{147} was studied on a coincidence scintillation gamma-spectrometer and a magnetic double-lens beta-spectrometer. The isotope Gd^{147} was obtained from the spallation of tantalum, and the measurements were ordinarily taken 10 to 20 hours after the irradiation of the Ta. Beta conversion transitions of Gd^{147} were detected at 1580, 1675 and 1810 kev in addition to the previous transitions at 310, 1070, 1130 and 1330 kev. The gamma spectrum was taken on a 100-channel scintillation counter with a 4×4 NaI(Tl) crystal (half-width of the 660 kev Cs^{137} line $\sim 10\%$). Gamma peaks were found at 620, 770, 900, 1100, 1330, 1550 and 1750 kev. Since Eu^{147} has an isomeric state at 625 kev with a relatively long lifetime, the "instantaneous" cascades can be separated from the cascades going through the isomeric state by a study of the $\gamma\gamma$ -coincidences. The "instantaneous" coincidences were measured at a resolving time of $\tau = 7 \times 10^{-8}$ and the delayed coincidences at a resolving time of $\tau = 2 \times 10^{-7}$. Instantaneous coincidences were observed at 310, 390, 540, 760, 890, 1130, 1330 and 1580 kev, and delayed coincidences at 370, 560 and 930 kev. No coincidences were observed at 1070, 1675 and 1810 kev. Sum peaks were observed at 230, 480, 630, 770, 930, 1070 and 1330 kev which can be interpreted as resulting from the cascades 230-1330 kev, 480-1070 kev, 630-930 kev and 770-770 kev. The lifetime of the 625-kev isomeric level was found to be $(8.0 \pm 0.6) \times 10^{-7}$ sec from the delayed coincidences. A decay scheme for Gd^{147} and Eu^{147} is presented on the basis of this data. (TTT)

30009 INVESTIGATION OF THE DECAY SCHEME OF Gd^{149} . A. A. Sorokin and K. P. Mitrofanov (Moscow State Univ.). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 808-12 (July 1961). (In Russian)

Measurements of Gd^{149} , which was obtained from the spallation of Ta and allowed to decay 10 days, were carried out on a 100-channel coincidence scintillation γ -spectrometer. The $e^- \gamma$ -coincidences were followed on a magnetic, double-lens β -spectrometer connected in coincidence with a γ -spectrometer. A decay scheme for Gd^{149} was constructed. The 150- and 496-keV levels are clearly discernible. Measurements of the delayed coincidences indicate that the 298-keV transition goes to the 496-keV isomeric level from the 794-keV level. A level with an energy of 940 keV is introduced because of the coincidence of the 150- and 790-keV γ -rays. A direct transition of 940 keV to the ground state is observed. The 461-keV transition takes place between the 957- and 496-keV levels. A level at 667 keV is proposed. There is a 272-keV transition to this level, and transitions of 517 and 667 keV from this level. A discussion of the quantum characteristics of the levels is given. (TTT)

30010 AN INVESTIGATION OF THE NEUTRON-DEFICIENT ISOTOPES OF Tb. A. T. Strigachev, L. S. Novikov, A. A. Sorokin, V. A. Khalkin, N. V. Tsvetkova, and V. S. Shpinel (Moscow State Univ.). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 813-25 (July 1961). (In Russian)

A terbium fraction was isolated from a tantalum target which had been irradiated with 660-MeV protons on a synchrocyclotron. The conversion electrons were recorded on thick layers of photofilm on a spectrograph having semicircular focusing and a constant magnetic field. The energy spectrum of the conversion electrons was studied from 90 to 650 keV by running a series of measurements at intervals of 150 to 250 keV on a β -spectrometer with a transverse magnetic field which effected double focusing of the electrons at an angle of $\pi/2$. A gas-filled Geiger-Mueller counter was used as a detector. A 100-channel coincidence scintillation counter with a 3.0×1.4 cm NaI(Tl) crystal was used to measure the $\gamma\gamma$ -coincidences. Three gamma transitions of 165.1, 351.9 and 187.5 keV were assigned to Tb^{149} ($T = 4$ hrs). It is assumed that the 165.1- and 187.5-keV gamma-transitions form a cascade parallel to the 351.9-keV transition. It is proposed that the 638.6-keV γ -transition in Gd^{150} is fed by the positron decay of Tb^{150} . In Gd^{151} the 108.3-keV γ -transition goes from the 108.3-keV level to the ground state. It is proposed that the 251.3- and 287.3-keV γ -transitions in Gd^{151} originate from the 359.6- and 395.6-keV levels respectively, and go to the 108.3-keV level. The 395.6-keV γ -transition is assigned to Tb^{151} as a direct transition to the ground state. A 180.1-keV γ -transition is assumed to originate at the 575.7-keV level and to terminate at the 395.6-keV level. The 478.3-keV transition observed in the conversion electron spectrum is assigned to the decay of Tb^{151} because of a coincidence peak at 480 keV. A proposed scheme for the levels in Gd^{152} is given, and compared with the recent results obtained by Toth on the decay of Tb^{152} . A large number of unassigned conversion lines were detected which are apparently associated with the decay of Tb^{151} , Tb^{152} or Tb^{154} . (TTT)

30011 THE POSITRON SPECTRA OF THE NEUTRON-DEFICIENT ISOTOPES OF TERBIUM AND NEODYMIUM. N. A. Bonch-Osmolovskaya, B. S. Dzhelepov, O. E. Kraft, and Yüeh-wa Chou. *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 826-31 (July 1961). (In Russian)

Neutron-deficient isotopes of Tb and Nd were obtained from the spallation of tantalum with 660-MeV protons. The measurements were carried out on a β -spectrometer with triple focusing. The terbium fraction showed the well-

known spectrum of Tb^{152} with a half-life of 18 ± 2 hr. An activity with a half-life of 3.1 ± 0.4 hr and three beta energies of 3600, 2800 and 1500 keV were assigned to Tb^{150} . An activity having a half-life of 66 ± 10 min and a beta energy of 4600 keV, and possibly, a 2600-keV beta, was assigned to Tb^{148} . In addition to the well-known decay chain $Nd^{140} \xrightarrow[3.3 d]{e^-} Pr^{140} \xrightarrow[3.5 min]{e^-, \beta^+} Ce^{140}$ (stable), the neodymium fraction indicated the presence of the chain $Nd^{139} \xrightarrow[5.2 hr]{e^-, \beta^+} Pr^{139} \xrightarrow[4.5 hr]{e^-, \beta^+} Ce^{139}$. The beta spectrum of Nd^{139} showed beta energies of 3300 ± 100 , 1000 ± 100 and 460 ± 60 keV with an intensity ratio of 1:0.084:0.024. Two conversion electron lines were found in the neodymium fraction at $E_\gamma = 694$ and 1442 keV. (TTT)

30012 AN INVESTIGATION OF THE COULOMB EXCITATION OF NUCLEAR LEVELS BY MEANS OF ACCELERATED, MULTI-CHARGED IONS. D. S. Andreev, V. A. Vasil'ev, G. M. Gusinskii, K. I. Erokhina, and I. Kh. Lembergt. *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 832-47 (July 1961). (In Russian)

The Coulomb excitation of a number of nuclear levels could be studied by increasing the energy of multicharged ions accelerated in a cyclotron. Thus 16- to 18-MeV Ne^{20} ions were used to study nuclear levels in Li and B, and also to excite the higher levels in such nuclei as Mg^{25} , Mg^{26} , Ca^{44} , Co^{59} , In^{115} and Sb. Levels having energies of 1.4 to 1.6 MeV were excited in heavy nuclei such as Ba^{138} and Ce^{140} by using 52.5-MeV N^{14} ions. The excitation probability for the 1.83-MeV level in Mg^{26} was found to be $B(E2) \uparrow = 0.035 \times 10^{-48} e^2 cm^4$. A value of $B(E2) \uparrow = 0.040 \times 10^{-48} e^2 cm^4$ was found for the 1.37-MeV level in Mg^{24} by using 16.8- to 18-MeV nitrogen ions and the 0.56-MeV level in Se^{76} as a reference level. The value of $B(E2) \uparrow$ for Se^{74} was close to that for Se^{76} , even though the energy levels differ noticeably (0.635 and 0.560 MeV). A value of $B(E2) \uparrow = 0.27 \times 10^{-48} e^2 cm^4$ was obtained for the 1.60-MeV level in Ce^{140} which has a closed neutron shell. This value is smaller by a factor of 1.5 than that obtained for the 0.65-MeV level in Ce^{142} . The experimental values of $B(E2)$ for the even isotopes of Sn, Ba^{138} and Ce^{140} were compared with theoretical value obtained from Kisslinger and Sorensen and found to be in good agreement with each other. The total lifetime τ was determined for the even-even nuclear levels and also for the 0.72-MeV level in B^{10} and the 0.58-MeV level in Mg^{25} . Spin values are assigned to the 1.19- and 1.43-MeV levels in Co^{59} , the 1.5-MeV level in In^{115} and the 1.05- and 1.12-MeV levels in Sb. It was assumed that the spin values do not differ by more than two units between the ground state and the excited state. Since the value of τ , the total lifetime, was known for the 0.48-MeV level in Li^7 , the 1.61-MeV level in Mg^{25} and 0.16-MeV level in Sn^{117} , the value of δ^2 or the relative intensity of transitions of the E_2 and $M1$ type could be determined by comparing τ with the measured value of $\tau(E2)$. The measured value of F (the ratio of $B(E2) \uparrow$ to the calculated value of $B(E2) \uparrow$ from the assumption of an independent particle) indicates the collective nature of the levels in even-even nuclei, and also of the 0.48-MeV level in Li^7 , the 1.61-MeV level in Mg^{25} and of the levels in Co^{59} , In^{115} and Sb. (TTT)

30013 THE β - AND γ -SPECTRA OF THE RADIOACTIVE ISOTOPES Sb^{113} AND Sb^{115} , AND THE NEW ISOMER Sb^{113} . I. P. Selinov, V. L. Chikhladze, D. E. Khulelidze, and N. A. Vartanov. *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 848-53 (July 1961). (In Russian)

The reactions $Sn^{112}(d, n) Sb^{113}$ and $Sn^{114}(d, n) Sb^{115}$ were

utilized by bombarding enriched targets of tin foil with 11-Mev deuterons on a cyclotron. The antimony activity was electrochemically deposited on a copper foil and subjected to analysis in a magnetic lens β -spectrometer. The Fermi plot for positron emission in Sb^{115} was a straight-line, and the maximum energy of the β^+ emission was at 1510 keV. Two conversion electron lines (K and L) were associated with the 499 keV γ -transition in Sb^{115} . The ratio $N_{eK}/N_{eL} = 0.0183$. The conversion electron coefficient was found to be $\alpha_K = 0.0064 \pm 0.0007$. The ratio $K/L = 6.5 \pm 1$. Hence, it is inferred that the transition is either M1 or E2. Since the Fermi plot is a straight line and $\lg ft = 4.7$, it follows that the β^+ -transition is allowed. The difference in mass between Sb^{115} and Sn^{113} was found to be 3050 keV from the decay scheme, and this value is in good agreement with the theoretical value of 3300 keV. The positron spectrum of Sb^{113} is more complex with two positron components having maximum energies of 2420 and 1800 keV. Its calculated β^+ transitions to the lower excited level are 45%, while the electron capture transitions to this level are 18%. The β^+ transitions to the higher level are 18% and the electron captures to this level are also 18%. A γ -spectrum taken on a scintillation spectrometer showed that the γ -lines at 320, 725, 885, 975, 1040 and 1230 keV are associated with a half life of 7 min (Sb^{113}). The 320- and 1040-keV γ lines are the most intense. Electrons having energies of 49.6, 75.3 and 77.9 keV were found in studying the conversion electron spectrum of Sb^{113} . These were identified as the K-, L- and M-conversion lines of the γ -transition $E_\gamma = 79.3$ keV. A ratio of $K/L = 1.7 \pm 0.1$ was measured experimentally. These data indicate that Sb^{113} forms a new isomer Sn^{113*} with a half-life of 21 min in addition to the long-lived isotope Sn^{113} with a half-life of 118 days. (TTT)

30014 A STUDY OF THE LEVELS OF P^{31} BY MEANS OF THE $\text{Si}^{30}(\text{p}\gamma)\text{P}^{31}$ REACTION. A. K. Val'ter, S. P. Tsytko, Yu. P. Antuf'ev, E. G. Kopanets, and A. N. L'vov (Inst. of Physics and Tech., Academy of Sciences, USSR). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 854-61 (July 1961). (In Russian)

Thin targets of Si^{30} were irradiated with 1- to 2.7-Mev, monoenergetic protons from an electrostatic generator. The γ -ray yield was determined by means of a $3 \text{ cm} \times 2 \text{ cm}$ CsI (Tl) crystal equipped with a photomultiplier. The γ -ray spectrum was taken on a 100-channel coincidence scintillation spectrometer. The angular distribution of the γ -rays was obtained by measuring the spectra at various angles. The γ -ray yields indicate well-marked resonances at proton energies of $E_p = 1096, 1205, 1326, 1393, 1402, 1482$ and 1516 keV which were investigated in greater detail by measuring the γ -spectra and angular distribution. A spin of $5/2$ is assigned to the 8.352-Mev level at a proton energy of 1096 Mev. The γ -ray angular distribution had the form $W = 1 - 0.5 \cos^2 \theta$. The results of measuring the γ -ray angular distributions show that all transitions to the first excited level and to the ground state of P^{31} are dipole transitions. The spins of the 8.46-Mev and 8.575-Mev resonance levels are $5/2$ at $E_p = 1393$ keV. The spin of the 8.647 excitation level is $3/2$ at $E_p = 1402$ keV. The 8.725-Mev resonance level is the only level showing a direct γ -transition to the ground state. Its spin is $3/2$ at $E_p = 1482$ keV. The spin of the 8.758-Mev resonance level at $E_p = 1516$ keV can have a value of $1/2$ or $3/2$. A diagram for the γ -transitions between these seven resonance levels in P^{31} , and the intensities of the transitions are presented. (TTT)

30015 THE TOTAL IONIZATION CREATED BY ALPHA PARTICLES IN A MIXTURE OF GASES. G. E. Kocharov (Inst. of Physics and Tech., Academy of Sciences, USSR).

Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz., 25: 862-5 (July 1961). (In Russian)

The resolution of an ionization α -spectrometer is determined by the fluctuation in the number of ion pairs formed by an alpha particle in a gas. The relative fluctuation in the number of ion pairs is $\sqrt{\Delta N^2}/N = \sqrt{F}/N$, where $N = E/U$ is the number of ion pairs, U is the average energy required to form a single ion pair, E is the energy of the α -particle, and F is a parameter depending on the type of gas. It has been found experimentally that the average energy required to form a single ion pair exceeds the ionization energy, because part of the energy of the α -particle is expended in the excitation of atoms. If an impurity is introduced and the ionization energy of the impurity is less than the excitation energy for the atoms of the main gas, an additional number of ion pairs can be formed with a resulting increase in the resolving ability of the α -spectrometer. Thus, an addition of 0.5% acetylene to argon increases the ionization by 29%. On analyzing various reaction mechanisms, it is concluded that all the excited gas atoms go to the ground state by interacting with the impurity atoms. The total number of ion pairs increases with increasing concentration of the impurity, and attains a maximum at some intermediate concentration of the impurity. It is computed that 40% of the energy of an α -particle is consumed in the excitation of atoms. The mean free path of the excited atom at 760 mm Hg pressure is less than 1μ . Hence, the addition of an impurity results in an increase in the number of ion pairs without impairing the operation of the ionization chamber. (TTT)

30016 MEASUREMENT OF THE MASSES OF TIN AND ANTIMONY ISOTOPES. R. A. Demirkhanov, T. I. Gutkin, O. A. Samadashvili, and I. K. Karpenko. *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 871-3 (July 1961). (In Russian)

Measurements of the masses of tin and antimony isotopes were carried out on a mass-spectrograph with double focusing over the entire mass scale by doublet comparison. Vapors of substances such as $\text{Sn}(\text{CH}_3)_4$, SbCl_3 , C_2H_{12} and $\text{C}_7\text{H}_6\text{O}_2$ were used in obtaining the doublets. Because of the high resolution of the mass-spectrograph (10,000 to 12,000), it was possible to resolve doublets such as $\text{C}_{m-1}^{12}\text{H}_n^{16}\text{O}_k^{16} - \text{C}_{m-1}^{13}\text{H}_n^{12}\text{O}_k^{16}$. Thus, it was necessary to correct for the C^{13} content in the comparison material. Three control doublets having known mass differences were run at mass numbers of 121, 122 and 123 to eliminate systematic errors. The results indicated reliable operation of the mass-spectrometer. The mass-defects of the tin and antimony isotopes are calculated and compared with data from other sources. The mass differences between neighboring isotopes of tin and antimony were calculated and compared directly with the mass differences obtained from the measured Q values of various nuclear reactions. The agreement between the two values was satisfactory in most cases. (TTT)

30017 THE RATIO OF THE PROBABILITIES OF α -DECAY AND E-CAPTURE FOR THE ISOTOPES $\text{Po}^{200,201,203}$. B. N. Belyaev, A. V. Kalyamin, and A. N. Murin (Khlopin Radium Inst., Academy of Sciences, USSR). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 874-8 (July 1961). (In Russian)

Polonium isotopes were obtained by a (p, xn) reaction on a Bi cyclotron target. A 31-channel ionization chamber was used to resolve alpha peaks, and a 4π scintillation counter was used to measure the electron capture. Since a direct determination of the fraction of α -decay and electron capture is difficult in this case, Po^{206} with a ratio of $\alpha/(E + \alpha) = (5 \pm 1)\%$ was used as a standard reference source.

The Bi target was dissolved in 6N HCl, and the Po was extracted with 20% TBP and back-extracted with HNO₃. Then, the Po was electrodeposited onto a silver disk. After 9 to 10 hours, the Bi and Pb daughter products were rinsed from the silver disk with 1.0 N HNO₃, and separated by ion exchange on a cation column. The ratio of the amount of Po²⁰³ (from the growth and decay of Pb²⁰³) to the amount of Po²⁰⁵ (from the decay of Bi²⁰⁵) was determined in the Bi fraction. The ratio of the amounts of Po²⁰⁰ and Po²⁰¹ (from the amounts of Pb²⁰⁰ and Pb²⁰¹ present) to the amount of Po²⁰³ (from the decay of Pb²⁰³) was determined in the Pb fraction. The ratio of the amount of Po²⁰⁵ (from the decay of Bi²⁰⁵) to the yield of Po²⁰⁶ (from the decay of Bi²⁰⁶) was determined from the Bi fraction which had grown in the Po over a period of 2 to 4 days. Thus, the yields of Po^{200,201,203} could be related to the total amount of Po²⁰⁶. The values of $\alpha/(E + \alpha)$ were found to be (0.80 \pm 0.23)% for Po²⁰⁰, (0.79 \pm 0.31)% for Po²⁰¹ and \sim 0.02% for Po²⁰³. Values of the half-life were found to be 11.2 min for Po¹⁹⁹, 17.5 min for Po²⁰¹, 44.5 min for Po²⁰², 3.54 hr for Po²⁰⁴, 9.5 days for Po²⁰⁶ and 12.6 hr for Pb²⁰⁰. Values of the reduced surface probability δ_0^2 were calculated from the relation $\lambda = \delta_0^2 P/\hbar$, where λ is the decay constant, and P is the quantum mechanical barrier penetrability. (TTT)

30018 THE REDUCED DERIVATIVE WIDTH δ_0^2 FOR THE ISOTOPES OF Po. B. N. Belyaev, A. V. Kalyamin, and A. N. Murin (Khlopin Radium Inst., Academy of Sciences, USSR). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 879-81 (July 1961). (In Russian)

The reduced derivative width characterizes the probability of α -decay in the absence of a coulomb barrier and is given by $\delta_0^2 = \lambda\hbar/P$, where λ is the disintegration constant for α -decay and P is the penetrability of the coulomb barrier. Values of δ_0^2 for the isotopes Po²⁰⁰ through Po²¹⁰ were obtained from experimental data and theoretical data on the assumption of an infinitely deep well. The experimental values were calculated from the ratio of alpha decays to electron captures plus alpha decays $\alpha/(E + \alpha)$, and from the partial half-lives of the isotopes. The plot of the experimental values of δ_0^2 versus the atomic number agrees qualitatively with the plot of δ_0^2 versus the atomic number which was calculated from Mang's theory who used an independent particle model. (TTT)

30019 CALCULATING CROSS-SECTIONS FOR THE FORMATION OF SPALLATION PRODUCTS. V. I. Baranovskii and A. N. Murin (Khlopin Radium Inst., Academy of Sciences, USSR). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.*, 25: 882-92 (July 1961). (In Russian)

The cross-section for the formation of a spallation product is considered for the case where a monoisotopic element is bombarded by fast protons. Rudstam found empirically that $\sigma(A, Z) = \exp [pA - Q - R(Z - SA)^2]$, where $\sigma(A, Z)$ is the cross-section, and A and Z are the mass number and atomic number of the isotope being formed. The factor Q is a normalizing multiplier; $p = d \ln \sigma / dA$; S determines the most probable ratio of Z/A for the spallation reaction products; and R is the width of the Gaussian distribution. Rudstam showed that $\lg p$ depends linearly on the log of the energy of the bombarding particle. Values of p, S and \sqrt{R} are calculated and tabulated for a number of spallation reactions after suitable modification of Rudstam's formula. The numerical data can be used to predict the cross-section for the formation of any specific element on irradiating a target with fast protons. An example is presented where the calculated yields are compared with the experimental yields for the spallation products obtained by irradiating Ag with 480-Mev protons. The average de-

viation of the calculated values from the experimental values is about 120%, and this result is considered satisfactory because of the large uncertainties in the experimental data itself. (TTT)

30020 THE Xe¹³⁵ YIELD IN THERMAL FISSION OF Pu²³⁹. J. G. Bayly, M. F. Duret, N. B. Poulsen, and R. H. Tomlinson (Atomic Energy of Canada Ltd., Chalk River, Ont. and McMaster Univ., Hamilton, Ont.). *Can. J. Phys.*, 39: 1391-3 (Sept. 1961). (AECL-1303)

To determine how much xenon-135 was removed from the 135 mass chain by neutron absorption in the thermal fission of plutonium-239, data were taken on a plutonium-aluminum sample and entered into an analog computer. The computer simulated the neutron flux and the iodine, xenon, and cesium differential equations from the data given. The results show that 28.9 atoms of xenon-135 were destroyed to form xenon-136 for every 78.2 atoms which decay to cesium-135. Thus the total xenon-135 produced was 37% greater than the measured cesium-135 yield. The results lead to a xenon-135 yield of $0.786 \times 6.90\% \times 1.37 = 7.43\%$ for this sample. The accuracy of this result is estimated to be 4.9% which corresponds to an error in the xenon-135 yield of 2.7% relative to the cesium-135 yield. (N.W.R.)

30021 FORMATION OF METASTABLE ISOMERS BY PHOTOACTIVATION WITH THE VAN DE GRAAFF ACCELERATOR. H. R. Lukens, Jr., J. W. Otvos, and C. D. Wagner (Shell Development Co., Emeryville, Calif.). *Intern. J. Appl. Radiation and Isotopes*, 11: 30-7 (Aug. 1961). (In English)

Bremsstrahlung from a 3 Mev 1 ma electron beam was used to form nuclear isomers Se^{77m}, Sr^{87m}, Rh^{103m}, Ag^{109m}, Cd^{111m}, In^{115m}, Lu^{176m}, Au^{197m}, Hg^{199m}, Y^{89m}, Sn^{117m}, Ba^{137m}, Hf^{179m}, Ir^{191m} and Pt^{195m} by photoactivation. The latter six isomers were prepared in this manner for the first time. In addition, the very short half-life activity generated in erbium can with little doubt be ascribed to Er^{167m}. Photoactivation appears to be a useful supplement to neutron activation as an alternate means of purely instrumental elemental analysis for most of the above elements in the 10 to 10,000 ppm range. It also has possible applications in determination of electron beam energy and in radiation dosimetry. (auth)

30022 NUCLEAR MAGNETIC RESONANCE STUDIES OF B¹¹ IN CRYSTALLINE BORATES. P. J. Bray, J. O. Edwards, J. G. O'Keffe, V. F. Ross, and I. Tatsuzaki (Brown Univ., Providence). *J. Chem. Phys.*, 35: 435-42 (Aug. 1961).

The coordination state of the boron atom in boron compounds may be correlated with the properties of the nuclear magnetic resonance (NMR) signals arising from the boron nuclei. Characteristic resonance line shapes occur when the NMR transitions are perturbed by interactions between the B¹¹ nuclear electrical quadrupole moment and the electric field gradient at the boron site. In polycrystalline borates, boron in trigonal and tetrahedral coordination may be resolved by analysis of first and second-order quadrupolar effects on the NMR transitions. The B¹¹ quadrupole coupling constants were measured for the simple trigonal BO₃ and tetrahedral BO₄ groups. The analysis was extended to include polyborate structures having both trigonal and tetrahedral boron atoms. Results of the NMR study of simple, known bonding configurations are discussed and correlated with measurements of alkali-borate glasses and of miscellaneous borate and mineral compounds. (auth)

30023 THE OPTICAL MODEL IN π -NUCLEAR SCATTERING. E. Leader (University Coll., London). *Nuclear Phys.*, 26: 177-92 (1961). (In English)

The optical potential for the pion- C^{12} interaction at 60 to 50 Mev is calculated in impulse approximation using the full energy dependence of the π -nucleon phase shifts. A critical discussion of the comparison with experimental well depths and differential cross sections is given. It is concluded that the model is perfectly adequate for predicting gross effects but that nothing conclusive can be said regarding its ability to account for the finer details, such as the differential cross-sections. (auth)

30024 THE ANGULAR DISTRIBUTIONS OF CHARGED PARTICLE GROUPS FROM THE DEUTERON BOMBARDMENT OF NITROGEN. W. M. Jones, D. G. Waters, and J. M. Rout (Associated Electrical Industries, Aldermaston, Berks, Eng.). *Nuclear Phys.*, 26: 203-8(1961). (In English)

The reaction mechanism for the P_0 , P_1 , P_2 , P_3 , and α_0 groups from the $N^{14}(d,p)N^{15}$ and $N^{14}(d,\alpha)C^{12}$ reactions in the region of 2 Mev bombarding energy appears to be predominantly that of compound nucleus formation with a comparatively small number of compound levels of opposite parity participating. These levels are not sufficiently numerous to be treated in a strictly statistical manner despite the high excitation energy of the O^{16} compound nucleus which is in the region of 22 Mev. (auth)

30025 ON FAVORED ALPHA TRANSITIONS. A. Sandulescu and M. Iosifescu (Institute for Atomic Physics, Bucharest). *Nuclear Phys.*, 26: 209-16(1961). (In English)

Using the collective model in the strong coupling scheme, it is established that the reduced width of a favored α transition with single angular momentum for an odd-mass nucleus of mass number A is proportional to the reduced width of the favored α transition with the same angular momentum for the even-even nucleus $A-1$, if both nuclei have the same deformation. This makes it possible to express the α intensities of odd-mass nuclei in terms of the reduced widths of the α transitions in even-even nuclei. Values of the latter widths extracted by Rasmussen from experimental data were used to calculate intensities of favored α transitions of odd-mass nuclei and relative intensities of their components of given angular momentum. The theoretical results are in good agreement with experimental data. (auth)

30026 DERIVATION OF STRONG INTERACTIONS FROM A GAUGE INVARIANCE. Y. Ne'eman (Imperial Coll. of Science and Tech., London). *Nuclear Phys.*, 26: 222-9(1961). (In English)

A representation for the baryons and bosons is suggested, based on the Lie algebra of the 3-dimensional traceless matrices. This enables us to generate the strong interactions from a gauge invariance principle, involving 8 vector bosons. Some connections with the electromagnetic and weak interactions are further discussed. (auth)

30027 YUKAWA TERMS IN THE UNITARY GAUGE THEORY. Y. Ne'eman (Imperial Coll. of Science and Tech., London). *Nuclear Phys.*, 26: 230-2(1961). (In English)

Considering higher order graphs, Yukawa terms are shown to appear in the unitary gauge theory under certain CP assumptions. (auth)

30028 PHOTOPROTONS FROM CARBON. V. J. Vanhuyse (Rijksuniversiteit, Ghent) and W. C. Barber. *Nuclear Phys.*, 26: 233-49(1961). (In English)

Energy and angular distributions of protons ejected from C^{12} targets bombarded by the beam of the Stanford Mark II accelerator were measured by a magnetic spectrometer.

The energy distributions, which are peaked at 6.0 Mev, show a structure that cannot be explained by a single resonance. Supposing that all transitions leave the residual nucleus in the ground state, the analysis of the proton distributions leads to a cross section which has a peak value of (12.7 ± 2.5) mb and values (41 ± 9) Mev \cdot mb and (77 ± 18) Mev \cdot mb when integrated from 0 to 24 and 40 Mev, respectively. Except for the peak value, the cross section curve is very similar to that of the $C^{12}(\gamma, n)$ reaction. The angular distributions of the (γ, p) and $(e, e'p)$ reactions were measured for different proton energy groups at an electron energy of 40 Mev. Except for a $\cos \theta$ term, the distributions are in agreement with the independent particle picture of the giant resonance, p- to d-wave transitions being the important ones. The results are also a confirmation of the theory of electron induced reactions. Yield curves as a function of electron energy were measured up to 40 Mev, for different proton energy groups and at different angles. Analysis of the yield curves leads to differential cross sections as a function of photon energy. The main property of these cross sections is to support to some extent the assumption of exclusively ground state transitions. (auth)

30029 ENERGY LOSS OF PROTONS IN RARE EARTH OXIDES AND REDUCED TRANSITION PROBABILITIES FOR $2^+ \rightarrow 0^+$ TRANSITIONS IN EVEN ROTATIONAL NUCLEI. G. Goldring and Z. Vager (Weizmann Inst. of Science, Rehovoth, Israel). *Nuclear Phys.*, 26: 250-8(1961). (In English)

Measurements of gamma yields from thick targets of rare earth oxides bombarded by protons were combined with lifetime measurements to determine reduced E2 transition probabilities in $2^+ \rightarrow 0^+$ rotational transitions. The rate of energy loss of the protons in the target was determined by a measurement of the absorption of the gamma in the target material at different proton energies yielding the mean penetration of the protons into the target. (auth)

30030 RELATIVE MEASUREMENTS ON THE LONGITUDINAL POLARIZATION OF BETA RAYS FROM Na^{24} , Mn^{56} , Sb^{122} , Ho^{166} AND Au^{198} . R. Sosnowski, Z. Wilhelmi and J. Wojtkowska (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). *Nuclear Phys.*, 26: 280-5(1961). (In English)

The longitudinal polarization of electrons from β -decay of Na^{24} , Mn^{56} , Sb^{122} , Ho^{166} and Au^{198} was compared. The degree of polarization was measured by the asymmetry in the electron scattering in a thin gold foil. Longitudinal electron polarization was changed into transverse polarization by means of crossed electric and magnetic fields. The measurements were carried out for the electrons with $v/c = 0.85$. The results for the asymmetry are $11.0 \pm 0.9\%$ (Na^{24}), $11.1 \pm 0.8\%$ (Mn^{56}), $10.1 \pm 0.3\%$ (Sb^{122}), $10.4 \pm 0.2\%$ (Ho^{166}) and $9.3 \pm 0.3\%$ (Au^{198}). The results suggest that the longitudinal polarization is not identical for the measured beta transitions. (auth)

30031 GENERALIZED SELF-CONSISTENT-FIELD AND RANDOM-PHASE APPROXIMATIONS FOR MULTI-PHASE SYSTEMS. D. E. McCumber (Univ. of Copenhagen). *Nuclear Phys.*, 26: 286-305(1961). (In English)

A formalism is presented which provides a basis for a rigorous unified quantal treatment of an extensive class of thermodynamic multi-phase many-particle systems. The thermodynamic phases considered are those associated with special spectral forms of the particle density operator, a type of hole-particle pairing operator. Fundamental to the formalism is the recognition that in self-bound systems characterized by a single "cluster," especially those whose position is not localized by external forces, the rel-

evant particle density is that measured relative to the center of mass. From a consistency requirement, derived equivalently from a generalized Hartree self-consistent-field approximation or from a type of random-phase approximation, an intrinsically non-linear integral equation is obtained whose solutions define a static background potential characteristic of the various phases. (auth)

30032 REDUCED WIDTHS FOR NUCLEON CLUSTERS IN SHELL MODEL. Yu. F. Smirnov and D. Chlebowska (Moscow State Univ.). Nuclear Phys., 26: 306-20(1961). (In English)

The reduced widths of nucleon clusters for certain low levels of p-shell nuclei are calculated on the basis of the shell model. The results of the calculation are in good agreement with experiment. In certain cases when the nature of the excited state is not uniquely determined, the comparison with experiment of the reduced widths of nucleon clusters for different variants of the structure of the wave functions makes it possible to eliminate non-uniqueness. The formal problems involved in calculation techniques are treated in detail. Simple expressions for the fractional parentage coefficients are given for the separation of several nucleons. (auth)

30033 THE $(\gamma, 3n)$ REACTION IN Pr^{141} . G. Moscati (Universidade, São Paulo, Brazil). Nuclear Phys., 26: 321-3(1961). (In English)

The isotope Pr^{141} was irradiated with a bremsstrahlung beam of 33-Mev maximum energy in the Saclay Linac. Activity due to Pr^{138} was detected and a lower limit of the integrated cross section from threshold to 33 Mev was obtained as being 1 Mev · mb. Some features of the accepted decay scheme are confirmed. (auth)

30034 THE STRUCTURE OF MOMENTUM SPACE, THE NEUTRINO AND THE PAULI PRINCIPLE. H. Fröhlich (Univ. of Liverpool). Nuclear Phys., 26: 324-37(1961). (In English)

Although right and left-handedness cannot be defined geometrically, the distinction between the two concepts can be so defined. From this observation it is concluded that the quantity in terms of which this distinction is made should be introduced as an explicit feature in the mathematical treatment of space. Application of this idea to null vectors in momentum space leads to an equation which formally is identical with the wave equation of the two-component neutrino field theory together with the reflected equation. Moreover, from the requirement of invariance of covariant quadratic expressions under phase transformation, it follows with necessity not only that the field must be quantized but also that this must be done according to the Pauli principle. A complete geometrical interpretation of the neutrino is thus obtained. The neutrino charge in particular is found to be given in terms of the newly introduced coordinate which describes the distinction between right- and left-handedness. (auth)

30035 INDUCED PSEUDOSCALAR INTERACTION IN $0^- \rightarrow 0^+$ BETA TRANSITIONS. D. Tadić (Institute "Rudjer Boskovic," Zagreb). Nuclear Phys., 26: 338-50(1961). (In English)

The induced pseudoscalar term is of the form $\beta\gamma_5(\psi_e \beta\gamma_5 \psi_\nu + (\alpha Z/r_0)\psi_e \gamma_5 \psi_\nu)$. In the case of nuclei with high Z , the second part of this expression is about 20 times larger than the first, which corresponds to the phenomenologically introduced pseudoscalar coupling. The correction factors for the spectrum and longitudinal polarization in $0^- \rightarrow 0^+$ transitions and the cross terms with the induced pseudoscalar in the allowed transitions are calculated. Numerical

analyses are undertaken for the $\text{Pr}^{144} \rightarrow \text{Nd}^{144}$ transition. A limitation on the ratio b_p/g_A of the induced pseudoscalar form factor b_p and the axial vector coupling constant g_A is found ($|b_p/g_A| \leq 2.7$, $|f| \leq 50$). All available experimental results can also be explained with $b_p \approx 0$. (auth)

30036 EXCITATION OF THE GIANT DIPOLE RESONANCE BY INELASTIC PROTON SCATTERING ON CARBON. E. A. Sanderson (Birmingham Univ., Eng.). Nuclear Phys., 26: 420-33(1961). (In English)

The inelastic scattering of 185 Mev protons, leaving the C^{12} nucleus in a "giant resonance" final state, is studied using the method of distorted waves. The distortion of the scattered proton is calculated in the semi-classical approximation using an optical potential with a theoretical root-mean-square radius equal to 3.04 fermi. The impulse approximation is employed. Coulomb corrections are also included. Comparison of the results with experiment is discussed. (auth)

30037 ANALYSIS OF RECENT MEASUREMENT OF NUCLEAR LEVEL DENSITY PARAMETERS. D. W. Lang (Australian National Univ., Canberra). Nuclear Phys., 26: 434-45(1961). (In English)

Data from experiments leading to values of the nuclear logarithmic level density derivatives are analyzed and shown to be reasonably self-consistent. A modified form of the curve for the value of the single particle level density parameter a is found to be in accord with the data. Attention is drawn to the effect of restriction of the allowed angular momentum of the emitted particles on the value found for the temperature in an evaporative process. (auth)

30038 THE MAGNETIC MOMENT OF THE SECOND EXCITED STATE OF F^{19} . R. M. Freeman (Cavendish Lab., Cambridge, Eng.). Nuclear Phys., 26: 446-51(1961). (In English)

The magnetic moment of the second excited state of F^{19} is determined by a direct measurement of the Larmor precession frequency after excitement of the state by the reaction $\text{F}^{19}(p, p')\text{F}^{19*}$. A value of $+3.69 \pm 0.04$ n.m. is obtained, where the error mainly arises from statistics. (auth)

30039 PROTON CAPTURE GAMMA RAYS IN THE GIANT RESONANCE REGION IN LIGHT NUCLEI. H. E. Gove, A. E. Litherland, and R. Batchelor (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nuclear Phys., 26: 480-510(1961). (In English)

The yield of capture gamma rays leading to the ground and first excited state of C^{12} and Si^{28} is measured in the proton energy range from 3 to 11 Mev. This covers a range of excitation energy including the peak of the giant dipole resonance. Similar measurements are made for Mg^{24} , except that in this case the combined yield of capture gamma rays leading to the ground and first excited state is measured. Angular distributions of both gamma rays in C^{12} and Si^{28} are also measured. The cross section at the peak of the yield for ground state gamma transitions on C^{12} (22.5 Mev excitation energy) is 1.3×10^{-28} cm² and the integrated yield is 4.7×10^{-4} Mev · bn. No fine structure is observed in the $\text{B}^{11}(p, \gamma_0)$ yield while considerable fine structure is found in the $\text{Al}^{27}(p, \gamma_0)$ and $\text{Al}^{27}(p, \gamma_1)$ yields. The yield of gamma rays to the first excited state does not reach a maximum at the same energy as that for the ground state in either C^{12} or Si^{28} . There is evidence for gross double peaked structure in Mg^{24} and a suggestion of it also in Si^{28} . The angular distributions indicate that direct capture ap-

plies, if at all, only for ground state gamma transitions in C^{12} . Forward asymmetry is observed in these distributions which cannot be interpreted as interference between two resonances of opposite parity separated by a spacing greater than their widths. (auth)

30040 EXPERIMENTAL STUDY OF THE CHARGE DISTRIBUTION OF O^{16} AND O^{18} BY ELECTRON SCATTERING. F. Lacoste and G. R. Bishop (Laboratoire de l'Accélérateur Lineaire, Orsay, France). Nuclear Phys., 26: 511-26 (1961). (In English)

The elastic scattering cross sections for 150 Mev electrons on O^{16} and O^{18} are compared for the scattering angles $\theta = 60, 90, 100$, and 110° . The inelastic cross section on O^{18} , up to 6 Mev excitation energy, is measured for the same angles. From these results the difference between the length parameters a of the harmonic well potential for O^{16} and O^{18} may be deduced. If $a_{18} = (1 + \epsilon) a_{16}$, this experiment gives $\epsilon = (2.5 \pm 0.6) \cdot 10^{-2}$. The lifetime of the 1.98 Mev excited state of O^{18} is found to be $\tau = (3.3 \pm 1.5) \times 10^{-12}$ sec. (auth)

30041 NUCLEONICS DATA SHEET NO. 43—GAMMA-RAY SPECTRA. 42 GAMMA SPECTRA OF SHORT-LIVED NUCLIDES. Minoru Okada (Government Chemical Industrial Research Inst., Tokyo). Nucleonics, 19: No. 9, 79-81 (Sept. 1961).

Gamma spectra of nuclides with half lives from 1 sec to 6 min were investigated. Samples were enclosed in polyethylene capsules and irradiated in the Japan Research Reactor-1. After activation, the gamma spectra of the samples were measured with a NaI(Tl) crystal spectrometer. (L.N.N.)

30042 POLARIZATION IN PROTON-BERYLLIUM AND PROTON-PROTON SCATTERING AT 1.7 Gev. P. Bareyre, J. F. Detoeuf, L. W. Smith, R. D. Tripp, and L. Van Rossum (C. E. N., Saclay, France). Nuovo cimento (10), 20: 1049-66 (June 16, 1961). (In English)

The polarization in p-Be and p-p scattering was measured by counter techniques at a proton kinetic energy of 1.74 Gev. The maximum polarization in p-Be scattering was found to be $P_{\max} = 0.19 \pm 0.04$ and occurs at an angle $\theta_{\max} \geq 3.5^\circ$. Inelastic scattering was rejected when the inelastic momentum loss was more than about 1% in the first scatter (magnetic analysis) or more than about 5% in the second scatter (Cherenkov threshold counter). The maximum polarization in p-p scattering is $P_{\max} = 0.30 \pm 0.09$ and occurs at an angle $35^\circ < \theta_{\max} < 55^\circ$ (c.m.). The angular dependence of the polarization is consistent with a distribution proportional to $\sin 2\theta$ within large statistical errors. Optical model calculations applied to the data on p-Be scattering yield an almost all imaginary central potential of about 43 Mev and a spin-orbit potential of between 0.9 and 2.0 Mev which is also almost all imaginary, in contrast with the predominantly real spin-orbit potential needed to explain the large polarization in the region of several hundred Mev. (auth)

30043 FURTHER STUDIES ON THE DECAY OF ^{132}Cs . S. Jha, R. K. Gupta, H. G. Devare, and G. C. Pramila (Tata Inst. of Fundamental Research, Bombay). Nuovo cimento (10), 20: 1067-78 (June 16, 1961). (In English)

The 6.48-day Cs^{132} has been made by the neutron-irradiation of natural Ba and chemical separation of Cs from Ba, and by 90 Mev proton bombardment of Cs. The following γ -rays were observed in a scintillation spectrometer: 670 keV (100), (1040 \pm 20) keV (0.25 \pm 0.03), (1140 \pm 20) keV (0.55 \pm 0.06), (1320 \pm 20) keV (0.75 \pm 0.08),

(1700 \pm 30) keV (0.01 \pm 0.005), (1800 \pm 30) keV (0.02 \pm 0.005) and (1980 \pm 30) keV (0.04 \pm 0.01). By conventional coincidence and summing technique studies, the feeding of the following levels in Xe^{132} is inferred: 670 keV (93%), 1320 keV (1%), 1450 keV (0.1%), 1700 keV (0.6%), 1800 keV (1.2%), and 1980 keV (0.6%). These levels have perhaps the spin and parity 2^+ , 2^+ , 4^+ , 2, 2, and 2, respectively. The positron branching to the 670 keV state is about 1.2%. The β^- -decay to the 470 keV state of Ba^{132} is less than 3%. The decay energy of Cs^{132} is inferred to be about 2100 keV. A decay scheme is suggested. (auth)

30044 ON THE UNIQUENESS OF A POTENTIAL FITTING A SCATTERING AMPLITUDE AT A GIVEN ENERGY. A. Martin and Gy. Targonski (CERN, Geneva). Nuovo cimento (10), 20: 1182-90 (June 16, 1961). (In English)

It is shown that when a scattering amplitude is known to be produced by a superposition of Yukawa potentials, the exact knowledge of the scattering amplitude at a given energy determines in a unique way the potential. This is established in two steps: (i) by proving that, once the physical scattering amplitude is known, the discontinuity across the cut in the complex plane of the momentum transfer is uniquely defined; (ii) by establishing the rigorous connection between this discontinuity and the potential. In order to be fitted by a superposition of Yukawa potentials at a given energy a scattering amplitude has to satisfy certain conditions which are investigated. The treatment can be modified in order to include the case of exchange forces. (auth)

30045 MODIFICATION OF THE CHEW-LOW FORMULA FOR THE $(\frac{1}{2}, \frac{3}{2}) \pi\text{-}\eta$ RESONANCE. W. M. Layson (CERN, Geneva). Nuovo cimento (10), 20: 1207-8 (June 16, 1961). (In English)

The Chew-Low formula $(\eta^3/\omega^*) \cotg \alpha_{33} = (3/4f^2) [1 - (\omega^*)/(\omega_0)]$, where $\eta = (p/m_\pi c)$ and p is the π -meson c.m. momentum, $(mc^2\omega^*)$ is the $\pi\text{-}\eta$ c.m. energy less one nucleon mass, ω_0 is the resonance value, and f is the coupling constant, is modified for $\omega^* > \omega_0$. This is accomplished by using $\eta^3[V(K)]^2$ instead of η^3 , where K is the wave number $\eta(\hbar/m_\pi c)$. A Yukawa source distribution is used to give a smooth cutoff for $V(K)$ or $V(\eta)$. (L.N.N.)

30046 RELATIVISTIC PION-NUCLEON SCATTERING WITH THE DETERMINANTAL METHOD. N. Bali, C. Gari-botti, J. J. Giambiagi, and A. Pignotti (Universidad, Buenos Aires). Nuovo cimento (10), 20: 1209-11 (June 16, 1961). (In English)

A method is presented for improving the scattering amplitude series for $t(\omega)$ up to a certain order in perturbation theory. This determinant method is used to investigate the resonant behavior of the $\pi\text{-}\eta$ scattering in the 11, 13, 31, and 33 partial waves. (L.N.N.)

30047 VERY PRELIMINARY EVIDENCE FOR EVEN $K\pi$ PARITY FROM ASSOCIATED PHOTOPRODUCTION. J. J. Sakurai (Enrico Fermi Inst. for Nuclear Studies, Chicago). Nuovo cimento (10), 20: 1212-16 (June 16, 1961). (In English)

Evidence is reported of even $K\pi$ parity deduced from the angular distribution of associated photoproduction $\gamma + p \rightarrow K^+ + \Sigma^0$. Use is made of the determination of the sign of the coefficient of the one-K-exchange pole term by the relative $K\pi$ parity. In extracting the OKE term from the observed angular distribution, it is assumed that only s-waves and sp-interference are significant for contributions other than the OKE term, since the de Broglie wavelength of the K

particle in the c.m. system is as long as 1.0×10^{-13} cm at the energy where the analysis is carried out. It is found that odd $K\pi$ parity is excluded by about two standard deviations and that the resulting scalar $K\pi\eta$ coupling constant is of the order of 0.6. (L.N.N.)

30048 PION-HYPERON RESONANCE FROM \bar{K} NUCLEON COULOMB CONSTRUCTIVE S-WAVE PARAMETERS. G. Costa (Università, Padua and Istituto Nazionale di Fisica Nucleare, Padua), F. Ferrari, and M. Pusterla. *Nuovo cimento* (10), 20: 1224-7 (June 16, 1961). (In English)

It is shown that a Coulomb constructive $K^-\eta$ scattering amplitude can generate a resonance in the $I = 1$ S-wave amplitude of the meson (π)-hyperon system, if the long range force (due to $KK-\pi\pi$ interaction) is taken into account. (L.N.N.)

30049 A PROPOSED EXPERIMENTAL TEST OF THE DAY, SNOW, AND SUCHER ARGUMENT BASED ON ANTI-PROTON ANNIHILATION INTO KAONS. B. d'Espagnat (CERN, Geneva). *Nuovo cimento* (10), 20: 1217-18 (June 16, 1961). (In English)

The protonium annihilation modes, $\bar{p} + p \rightarrow K_1^0 + K_1^0$, $K_2^0 + K_2^0$, or $K_1^0 + K_2^0$ are used in testing a general argument (T. B. Day, G. A. Snow, and J. Sucher, *Phys. Rev. Lett.*, **3**: 61 (1959) on predominant S-state sorption. It is suggested that if this argument applies, annihilations at rest into two mesons (K^0) will all be of the type $\bar{p} + p \rightarrow K_1^0 + K_2^0$, otherwise the annihilation would occur predominantly from P states. This distinction cannot be extended to the cases where charged or neutral π -mesons are emitted together with the K-mesons. (L.N.N.)

30050 A CALCULATION OF NUCLEAR ABSORPTION OF MESONS μ^- IN O^{16} . E. G. Beltrametti (Università, Genoa and Istituto Nazionale di Fisica Nucleare, Genoa) and G. Florio. *Nuovo cimento* (10), 21: 84-7 (July 1, 1961). (In Italian)

A shell model analysis is given for the energy spectrum of the neutrons ejected in μ^- absorption by O^{16} . (auth)

30051 THE RESONANT PION-PION MODEL FOR THE NUCLEON STRUCTURE. S. Bergia and A. Stanghellini (Università, Bologna). *Nuovo cimento* (10), 21: 155-68 (July 1, 1961). (In English)

A theoretical model based on strong $\pi-\pi$ interaction is compared with experimental data on nucleon form factors and the determination of the parameters is discussed. The qualitative evaluation of the positions of the two and three pion resonances given is not in disagreement with the existing data, but a wide range of values are allowed for the parameters. The situation is not clear in view of some difficulties in the interpretation of the neutron form factors. (auth)

30052 EQUILIBRIUM FAMILIES IN THE LIQUID DROP MODEL. S. Gallone (Università, Milan). *Nuovo cimento* (10), 21: 194-6 (July 1, 1961). (In English)

A semiquantitative classification of distinct series of equilibrium shapes of a nucleus treated according to the classical liquid drop model is given by Cohen and Swiatecki. These men have also indicated the importance of nucleus shape in connection with the theory of fission. In this investigation the problem is treated quantitatively using formulas already derived by Businaro and Gallone to obtain the interrelation between the different equilibrium series. The problem is limited to the case of P_2 deformations superimposed on the basic ellipsoid. Graphs are given for the behavior of the $\Phi(y,x)$ function and the values of x cor-

responding to equilibrium configurations as a function of y . (N.W.R.)

30053 GAMMA RAYS FROM ^{150}Eu . G. Chilosi, P. Cuzocrea, R. A. Ricci, and G. B. Vingiani (Istituto Nazionale di Fisica Nucleare, Naples and Università, Naples). *Nuovo cimento* (10), 21: 376-8 (July 16, 1961). (In English)

The decay of Eu^{150} produced by $\text{Eu}^{151}(\gamma,n)$ reactions is investigated. The half life is found to be 14 ± 1 hours. Eu^{140} decays into both Sm^{150} and Gd^{150} , from both beta-decay energy systematics ($Q^+ \approx 3$, $Q^- = 1.1$ Mev) and from nuclidic mass computation ($Q^+ = 2.42$, $Q^- = 1.07$ Mev). The beta decay of Eu^{150} is assumed to occur mostly to the Gd^{150} ground state. For Sm^{150} , many levels are known from the radioactive decay of Pm^{150} and from nuclear reaction data. It is also shown that Eu^{150} decays with associated gamma rays, most of them belonging to Sm^{150} . (L.N.N.)

30054 REGULARITIES IN THE BRANCHING RATIOS FROM THE HIGHER EXCITED STATES OF THE EVEN-EVEN NUCLEI. R. van Lieshout (Instituut voor Kernfysisch Onderzoek, Amsterdam), R. A. Ricci, and R. K. Girgis. *Nuovo cimento* (10), 21: 379-82 (July 16, 1961). (In English)

Decay modes of the higher excited states are discussed for even-even nuclei. Regularities found indicate the possibility of establishing definite systematic properties in the de-excitation of levels above the low, well-established vibrational structure. (L.N.N.)

30055 ROTATIONAL BANDS IN Ne^{20} . A. E. Litherland, J. A. Kuehner, H. E. Gove, M. A. Clark, and E. Almqvist (Atomic Energy of Canada Ltd., Chalk River, Ont.). *Phys. Rev. Letters*, 7: 98-100 (Aug. 1, 1961).

The spectra from the excited states of Ne^{20} are grouped into rotational bands. One of these bands has levels with spins and parities 0^+ , 2^+ , 4^+ , and 6^+ ; another has 2^- , 3^- , 4^- , and 5^- ; another has 1^- and 3^- ; another has 0^+ , 2^+ , and 4^+ ; and another has 0^+ and 2^+ . The properties of these bands are discussed in terms of their K- and J-values, energies, spins, and parities. (T.F.H.)

30056 SCATTERING OF BeV ELECTRONS BY HYDROGEN AND DEUTERIUM. R. M. Littauer, H. F. Schopper, and R. R. Wilson (Cornell Univ., Ithaca, N. Y.). *Phys. Rev. Letters*, 7: 141-3 (Aug. 15, 1961).

Electron scattering by hydrogen and deuterium was measured at 45° , 90° , and 135° . Differential elastic scattering cross sections and electric and magnetic form factors are plotted. Form factors were determined by the method of intersecting ellipses. (L.N.N.)

30057 COMPARISON OF THE BETA SPECTRA OF B^{12} AND N^{12} . T. Mayer-Kuchuk and F. C. Michel (California Inst. of Tech., Pasadena). *Phys. Rev. Letters*, 7: 167-9 (Sept. 1, 1961).

The interference between the coupling in the beta interaction analogous to the anomalous magnetic moment of the nucleon and the Gamow-Teller transition amplitude for a $1^+ \rightarrow 0^+$, $\Delta T = 1$ beta transition results in a deviation from the allowed shape of the B^{12} and N^{12} spectra. The magnitude of this effect is calculated from the rate of anomalous M1 gamma transition in C^{12} . Results appear to be in agreement with theoretical predictions and are graphically represented. (L.N.N.)

30058 DOUBLE GAMMA EMISSION IN THE 6.06-Mev MONOPOLE TRANSITION OF O^{16} . S. Gorodetzky, G. Sutter, R. Armbruster, P. Chevallier, P. Mennrath, F. Scheib-

ling, and J. Yoccoz (Institut de Recherches Nucleaires, Strasbourg). *Phys. Rev. Letters*, 7: 170-2 (Sept. 1, 1961).

The 6.06 Mev level was excited by the $F^{19}(p,\alpha)O^{16}$ reaction at the 1880 kev resonance, this being the most advantageous resonance for a study of the monopole transition. An $(\alpha-\gamma-\gamma)$ triple coincidence ($2\tau = 5 \times 10^{-8}$ sec) gating a multichannel analyzer which records the energy spectrum of the alpha particles was used. The gamma rays were detected by two 4-in. \times 4-in. NaI crystals at 180° , and the alpha particles by a 20mm² RCA junction detector at 150° to the direction of the incident beam. Data are presented in graphical and tabular form, and subsequent apparatus improvements are described. (L.N.N.)

30059 MAGNETIC MOMENT OF N^{13} . M. Posner, J. L. Snider, A. M. Bernstein, and D. R. Hamilton (Princeton Univ., N. J.). *Phys. Rev. Letters*, 7: 173-4 (Sept. 1, 1961).

The spin and magnetic moment of 10-minute N^{13} was measured by the atomic beam magnetic resonance method. A continuous flow source was used. N^{14} was bombarded in melamine powder by 18-Mev protons and the resulting N^{13} was flushed with neon. It was then neutralized and passed through a machine consisting of a series of magnets. Finally, the atoms were collected on titanium foils and the positron activity was counted. N^{13} atoms were produced mainly in the $^4S_{3/2}$ state, nuclear spin was $1/2$, and the hyperfine structure separation, $\Delta\nu$, was 33.2 ± 0.3 Mc/sec. Data on the magnetic moments of pairs of mirror nuclei are tabulated, and it is shown that the mesonic current contributions in N^{13} and C^{13} , if they exist, obey the mirror principle. (L.N.N.)

30060 IDENTIFICATION OF DOUBLET STATES AT 5.16 Mev IN B^{10} . E. L. Sprenkel, J. W. Olness, and R. E. Segel (Aeronautical Research Lab., Dayton, Ohio). *Phys. Rev. Letters*, 7: 174-7 (Sept. 1, 1961).

Investigation of the 5.16 Mev level when fed by 2.40 Mev gamma transitions from the 7.56 Mev level in B^{10} yields results not supported when the 5.16 Mev is produced by other means. A study of this discrepancy was made, and another state in this energy region was found. The 7.56 Mev level decays by gamma rays to feed the $J = 1$, $T = 0$ broad level centered at 5.18 Mev, leaving the previously known narrow 5.16 Mev level for the $J^\pi = 2^+$, $T = 1$ state. (L.N.N.)

30061 ORIENTED NUCLEI. L. Rosenfeld (Nordisk Institut for teoretisk Atomfysik, Copenhagen). *Rend. Scuola intern. fis. "Enrico Fermi," Corso XI* (1959), 197-250 (1960). (In English)

Particle or photon emission from oriented nuclei is studied. Polarization effects in the emission of particles with integral or half-integral spins are outlined. Two- and three-particle correlations are examined. Attention is given to the correlations, particularly β - γ correlations, that are encountered in nuclear β decay. (T.F.H.)

30062 COUPLING CONSTANT DETERMINATIONS FROM INVESTIGATIONS OF NUCLEAR BETA-DECAY. O. Kofoed-Hansen (Danish Atomic Energy Commission, Risø). *Rend. Scuola Intern. fis. "Enrico Fermi," Corso XI* (1959), 251-79 (1960). (In English)

Methods are discussed for determining the electron ($+$ or $-$) polarization in nuclear β decay. The β - γ correlations in decay of oriented nuclei are reviewed. Decay of free polarized or unpolarized neutrons is studied. The β decay coupling constants calculated from these polarization considerations are compared with the constants calculated from recoil experiments (on Ne^{19} , Ne^{23} , Ar^{36} , He^6 ,

and n), and from mirror and near-mirror decays (of n , H^3 , O^{15} , F^{17} , Ca^{39} , O^{14} , Al^{26} , and Cl^{34}). (T.F.H.)

30063 THE RADIATIVE CAPTURE OF μ -MESON BY NUCLEUS. Li-ning Chang and Yuan-ben Dai (Academia Sinica, Peking). *Sci. Sinica (Peking)*, 10: 420-3 (Aug. 1961). (In English)

The probability of μ -meson radiative capture by a nucleus and the polarization of the emitted photon were calculated by using the Fermi-gas model. It was found that the weak anomalous magnetic moment and the pseudoscalar term contribute about 30% to the total probability. About 5% of the emitted photons are left-handed. (L.N.N.)

30064 ON POSSIBLE REORIENTATION OF NEUTRON SPIN IN THE REACTION $Be^9(d,n)B^{10}$. T. G. Gachechiladze and O. M. Mdivani. *Trudy Inst. Fiz. Akad. Nauk Gruzin. S.S.R.*, 7: 201-5 (1960). (In Georgian)

The reaction $Be^9(d,n)B^{10}$ (the energy of the incident deuterons is $E_d = 0.86$ Mev) for transitions to the ground and excited states of B^{10} is considered. (auth)

30065 ON THE DIFFRACTION INTERACTION OF DEUTERONS WITH SEMI-TRANSPARENT NUCLEI HAVING A DIFFUSE EDGE. O. (A.) G. Sitenko and V. K. Tartakovskii (Gor'kii Khar'kov State Univ., [USSR]). *Ukrain. Fiz. Zhur.*, 6: 12-19 (Jan.-Feb. 1961). (In Ukrainian)

Integral cross sections are found for the processes of the diffraction interaction of deuterons with semi-transparent nuclei having a diffuse edge. It is shown that the complete cross section, the cross section of elastic scattering, diffraction splitting, and absorption of deuterons decrease monotonously with an increase in transparency (with a decrease in the β parameter), while the cross section of neutron or proton stripping increases with an increase in transparency. All cross sections, except that of diffraction splitting, depend only slightly on the degree of diffuseness of the nuclear edge Δ . With a rise in Δ , these cross sections increase to some extent. The cross section of diffraction splitting greatly decreases with an increase in the diffuseness of the edge of the nucleus. Thus with $\Delta = R_d$ it is one order less than with $\Delta = 0$. (auth)

30066 COLLECTIVE EXCITATION CORRESPONDING TO QUADRUPOLE OSCILLATIONS ON NUCLEI. A. S. Davydov. *Vestnik Moskov. Univ., Ser. III*, 16: No. 1, 56-66 (Jan.-Feb. 1961). (In Russian)

Equations for resolving the rotational-vibrational spectra of non-spherical nuclei, considering γ oscillations, are analyzed. It was found that excited states with spin 0 are related either to β or γ oscillations. (tr-auth)

30067 ENERGY SPECTRA OF NUCLEI NEAR Pb^{208} . III. Pb^{208} AND Tl^{208} . Kêng-wei Jeng, Kuang-wêng Chou, Y-wêng Yü, Ch'ung-hua Chang, and Min Yü (Inst. of Atomic Energy, Academy of Sciences, Chinese National Republic). *Wu Li Hsüeh Pao*, 16: 27-37 (Jan. 1960). (In Chinese)

Energy spectra of Pb^{208} and Tl^{208} were studied by wave expansion. The calculations are in good agreement with experiment. The first excitation level, 3^- , is considered a surface 3rd-order oscillation. (tr-auth)

30068 GAMMA TRANSITION NEAR Pb^{208} . I. E2 AND E3. Ch'ung-t'ien Liang, T'ang-shih Hu, Hsiao-t'ien Ch'eng, Y-wêng Yü, and Min Yü (Inst. of Atomic Energy, Academy of Sciences, Chinese National Republic). *Wu Li Hsüeh Pao*, 16: 38-46 (Jan. 1960). (In Chinese)

Configuration and nuclear surface oscillation methods were used in calculating transition probabilities with the parameters $C_2 \sim 1000$ Mev, $C_3 = 350$ Mev, $\hbar\omega_3 = 2.6$ Mev,

and $\hbar\omega_2 = 5$ Mev. The results are in good agreement with experiments except for two E3 transitions in Pb^{206} . It is postulated that the configuration is the result of residual interaction. The rigidity and frequency configuration determine the E2 and E3 transition probabilities. (tr-auth)

30069 NUCLEAR ISOMERISM IN In^{116} . P. H. Heckmann, K. Gubernator, J. Pöyhönen, and A. Flammersfeld (Universität, Göttingen, Ger.). Z. Physik, 163: 451-6 (1961). (In German)

The short lived indium isomer produced by thermal neutron capture is confirmed to be In^{116} . A new determination of half-life and γ energy yields $T_{1/2} = (2.17 \pm 0.07)$ sec and $E_\gamma = (164 \pm 1)$ kev. From measurement of the K shell conversion coefficient it follows that the multipolarity of the transition is E3, leading to a spin and parity assignment of 8^- for the isomeric level. (auth)

30070 THE DETERMINATION OF THE SPIN POLARIZATION FROM TRANSPARENCY MEASUREMENTS IN OPTICAL PUMPS. W. Raith (Technische Universität, Berlin). Z. Physik, 163: 467-80(1961). (In German)

A simple method of measuring the degree of polarization achieved by optical pumping has been described recently for the case of sodium vapor, illuminated with the single circularly polarized D_1 line. The assumption had to be made, however, that the atomic absorption cross section Q , depending on the degree of polarization P and the frequency of light ν , may be approximated by $Q(P, \nu) = (1 - P) \cdot Q(P = 0, \nu)$. The purpose of this paper is to discuss the qualification of this assumption. A theoretical analysis of the pumping process is tried, showing that the measured polarization corresponds in good approximation to the degree of the valence electron spin polarization. For the case of weak absorption and equal intensity of the two hyperfine components of the D_1 line a diagram is given, relating the measured polarization to the polarization of the nuclear spin. (auth)

30071 PRINCIPLES OF THE THERMODYNAMICS OF A SYSTEM WITH DIFFERENT ORBITAL AND SPIN TEMPERATURE. [PART] I. E. Fick (Technische Hochschule, Munich). Z. Physik, 163: 481-8(1961). (In German)

The orbital and spin energies of a Fermi or Bose gas with different orbital and spin temperature depend on both temperatures. This new thermodynamic behavior demands a new formulation of the foundations of thermodynamics for such systems. In the present paper the fundamental thermodynamic notions (variables of state, work, adiabatic processes) are formulated, and the definition of an empirical orbital and spin temperature is given. The first law of thermodynamics, the definition of orbital and spin heat, and resulting conditions of integrability are discussed. There are four heat capacities (instead of the one for normal systems), the relations of which are stated. (auth)

Particle Accelerators

30072 (AERE/Memo-G/M-61) SHUNT IMPEDANCE, AXIAL FIELD AND GROUP VELOCITY CALCULATIONS AT 3,000 Mc/s FOR DIELECTRIC LOADED LINEAR ACCELERATORS. W. Walkinshaw and K. Lawson (Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England). June 29, 1950. 25p.

Results are presented for calculations of the waveguide shunt impedance, axial electric field, and group velocity for dielectric disk loaded accelerators at a wavelength of 10 cm. Graphs are presented for dielectric constants of 6, 16, and 95. (D.L.C.)

30073 (BNL-5603) INSTRUMENTATION FOR USE WITH BEV ACCELERATORS. W. A. Higinbotham (Brookhaven National Lab., Upton, N. Y.). [1961]. 10p.

Instrumentation for use in observing the interactions of high-energy protons with various nuclei, and in studying the short-lived resulting particles is described. Descriptions of millimicrosecond logic circuits for use with scintillation and Cherenkov detectors to select and analyze high-energy events are included. (J.R.D.)

30074 (CERN-60-26) THE CERN PROTON SYNCHROTRON. PART II. CHAPTER V. INJECTION. E. Regenstreif (European Organization for Nuclear Research, Geneva). July 29, 1960. 193p.

Discussions are given of the general arrangements of the injection system, the principles of the Alvarez structure of the proton accelerator, the ion source, the 500-kev pre-accelerator, beam focusing between the source and the accelerator, the beam buncher, beam steering coils and apertures, the linear accelerator, r-f power supply to the cavities, the adjustment of the accelerating field in the cavities, focusing the accelerator, phasing the accelerating cavities, matching the beam to the synchrotron, the beam debuncher, injection optics, and ancillary apparatus between the accelerator and the synchrotron. (B.O.G.)

30075 (CERN-61-21) LONGER PULSE LENGTH BY A VIBRATING TARGET IN THE CERN SYNCHRO-CYCLOTRON. B. Hedin (European Organization for Nuclear Research, Geneva). Aug. 3, 1961. 19p.

Proposed methods for use in lengthening pulses in the CERN synchrocyclotron are discussed. Included are discussions of the merits in suitable modulation programs, separate RF program for extraction, use of very small targets, and especially the use of vibrating targets. (J.R.D.)

30076 (CTSL-10) A PROTON SYNCHROTRON FOR 300 GEV. Matthew Sands (California Inst. of Tech., Pasadena. Synchrotron Lab.). Sept. 1960, Reprinted Feb. 1961. Contract AT(11-1)-68. 29p.

This report is an amended version of SL-10.

The concept of a proton synchrotron with a maximum energy of several hundred Bev is discussed. A description of the accelerator and a set of parameters for a tentative design are given. Justifications for the choices of the parameters are outlined. An estimate of the costs involved is presented. It was concluded that a proton synchrotron with a maximum energy of 300 Bev is both technically and economically feasible. (M.C.G.)

30077 (CTSL-11) MAGNET POSITIONING PROBLEMS FOR A 300 GEV PROTON SYNCHROTRON. Robert I. Hulsizer (California Inst. of Tech., Pasadena. Synchrotron Lab.). Oct. 20, 1960. Contract AT(11-1)-68. 12p.

The problems in magnet positioning for the 300-Bev proton synchrotron are discussed. Topics covered include relationships between magnet placement errors and the displacement of the beam, design of the foundations, stability of the earth over distances of 1 to 3 miles, and surveying techniques. (M.C.G.)

30078 (CTSL-13) CAPTURE EFFICIENCY OF A CONSTANT GRADIENT ELECTRON SYNCHROTRON. Charles Peck (California Inst. of Tech., Pasadena. Synchrotron Lab.). Feb. 1961. Contract AT(11-1)-68. 46p.

The problem of high-energy multi-turn injection into a constant gradient electron synchrotron from a linear accelerator was studied. The injected beam is characterized by a constant current with a well defined duration, a uniform energy distribution, and unspecified distributions in vertical and radial phase space. Calculations yielding the

optimum synchrotron parameters and surfaces of capture efficiency over the radial phase space have been made assuming an idealized synchrotron with the design parameters of the Caltech machine. On the basis of these calculations and the parameters of a commercially available linac, an upper limit of 10^{12} captured electrons for 10 Mev injection and half that at 5 Mev can be set. (auth)

30079 (CTSL-14) INJECTION FIELD CRITERIA FOR HIGH ENERGY SYNCHROTRONS. Matthew Sands (California Inst. of Tech., Pasadena. Synchrotron Lab.). Jan. 5, 1961. Contract AT(11-1)-68. 12p.

Quantitative criteria are proposed for distinguishing "high" and "low" injection fields in high energy accelerators. The distinction depends on the aperture scale as well as the synchrotron energy. (auth)

30080 (CTSL-21) R.F. SYNCHRONIZATION DURING TRANSFER IN THE CASCADE SYNCHROTRON. A. V. Tollestrup (California Inst. of Tech., Pasadena. Synchrotron Lab.). Mar. 21, 1961. Contract AT(11-1)-68. 11p.

Problems encountered in synchronizing the radiofrequency systems of two synchrotrons so that a bunch of protons in the injector may be transferred to a bucket in the main machine without the loss of particles are discussed. A method for synchronizing the two systems is presented. (M.C.G.)

30081 (CTSL-24) VACUUM REQUIREMENTS FOR THE CASCADE SYNCHROTRON. Vincent Z. Peterson (California Inst. of Tech., Pasadena. Synchrotron Lab.). Apr. 11, 1961. Contract AT(11-1)-68. 22p.

The principal characteristics of a vacuum system for the proposed 300-Bev cascade synchrotron are discussed. A study was made to determine whether the small aperture and large circumference of the main ring would present vacuum difficulties. Gas scattering losses, eddy currents in the vacuum chamber wall, and cost of a 5-mile vacuum system were also considered. Aperture requirements, assumed vacuum chamber and pole tip dimensions, eddy currents in a metal vacuum chamber, pump section conductance, outgassing sources, and minimum pump spacing are discussed. (M.C.G.)

30082 (CTSL-25) EFFECTS OF MAGNET NON-LINEARITIES ON BETATRON OSCILLATION FREQUENCIES FOR THE 300 BEV PROTON SYNCHROTRON. Jon Mathews (California Inst. of Tech., Pasadena. Synchrotron Lab.). Apr. 3, 1961. Contract AT(11-1)-68. 13p.

The effects of non-linear magnetic fields on betatron frequencies, in particular their variation with particle energy, were studied. An attempt was made to determine whether nonlinearities can be introduced in such a way that the number of betatron wavelengths in the circumference is independent of particle energy for energies near equilibrium energy. It was found that nonlinearities of a magnitude such that the field index varies by about 1% per cm would be sufficient. Since no definite magnet lattice was arrived at for the 300 Bev machine, some tentative and approximate numbers were adopted. (M.C.G.)

30083 (DESY-A-2.77) KORREKTUR DES FELD-GRADIENTEN DURCH POLE-FACE-WINDINGS. (Correction of Field Gradients through Pole-Face-Windings). G. Ripken (Deutsches Elektronen-Synchrotron, Hamburg). July 3, 1961. 14p.

The remanence phenomenon of the iron core of synchrotron magnet in small fields leads to important deviations of the field index, which are corrected usually with current carrying wire windings on the magnet contour, the so-called pole-face windings. In the present work the field

gradients, which are dependent on the form of the magnet surface, induced in the wire windings are calculated for the DESY magnets. The current intensity at any wire location on the contour is determined. This makes possible a good correction of the field index. (J.S.R.)

30084 (MURA-622) PROTON LINEAR ACCELERATOR CAVITY CALCULATIONS. Terry W. Edwards (Midwestern Universities Research Assn., Madison, Wis.). June 15, 1961. Contract AT(11-1)-384. 49p.

The calculation of electromagnetic eigenvectors and eigenvalues in linear accelerator type cavities containing drift-tubes, whose meridian-plane cross sections are piece-wise simply describable, can be accomplished by solving finite difference approximations to the wave equation. The resulting eigenfunctions and eigenvalues allow quantitative determination of particle dynamic and electromagnetic phenomena occurring within an operating linear accelerator. The development and method of use of these finite difference relationships are examined. Preliminary results computed from these relationships agree with known information. Computer programs were written for cavities whose shapes are applicable to low energy proton-linear accelerators. (auth)

30085 (NASA-TN-D-886) THEORY OF AN ELECTROMAGNETIC MASS ACCELERATOR FOR ACHIEVING HYPERVELOCITIES. Karlheinz Thom and Joseph Norwood, Jr. (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.). June 1961. 36p.

For an electromagnetic accelerator which employs an electromagnetic force for driving the projectile, the maximum velocity which can be obtained without melting the projectile by ohmic heating depends on the mass of the projectile. It is found that the gradient of the mutual inductance of the projectile and of the driving circuit is the factor of proportionality between velocity and mass. A scheme providing a continuously high gradient of the mutual inductance is investigated. (auth)

30086 (AEC-tr-4788) INVESTIGATION OF THE SPATIAL DISTRIBUTION OF BREMSSTRAHLUNG FROM A 5 MEV BETATRON. H. Kulenkampf, M. Scheer, and R. Schittenhelm. Translated by Douglas Venable for Los Alamos Scientific Lab. from Z. Physik, 129: 202-18(1951). 33p.

Measurements were made of the spatial distribution of bremsstrahlung from different target materials (Al, Cu, W) and with different thicknesses were carried out in an electron induction accelerator by means of the nuclear photo-effect in beryllium. The form of the distribution curves and the relative intensities were in good agreement with the statement of the radiation theory with consideration of multiple scattering of the electrons in thicker layers. (auth)

30087 (UCRL-Trans-703) ENLARGED VACUUM CHAMBER FOR THE PROTON SYNCHROTRON. REPORTS AND DRAWINGS COVERING WORK DONE WITH EPOXY RESINS, WITH AND WITHOUT GLASS FIBER REINFORCEMENT. C. Célarier (European Organization for Nuclear Research, Geneva). Translated for Univ. of California. Lawrence Radiation Lab., Berkeley). 1961. 37p.

Specifications are presented for manufacturing an enlarged vacuum chamber with stratified Araldite for the CERN proton synchrotron. Results are presented for chamber tests, tests evaluating the resistance of Araldite to neutrons, and gluing tests on Araldite. (D.L.C.)

30088 (UCRL-Trans-704) A PORTABLE NEUTRON GENERATING TUBE USING ION ACCELERATION. E. A. Ab, G. M. Andrianov, R. I. Plotnikov, and L. A. Hutsishvili. Translated by Richard B. Crawford for Univ. of California. Lawrence Radiation Lab., Berkeley from Pribory i Tekh. Ekspt., 6: No. 1, 129-30(1961). 5p.

Development and design of a portable miniaturized neutron generating test instrument are described for use in well-logging equipment. Neutrons are obtained by bombardment of zirconium deuteride targets with accelerated D ions resulting in a D-T reaction. (J.R.D.)

30089 DETERMINATION OF THE ENERGY AND OF THE ENERGY SCATTERING OF THE PROTON BEAM OF THE IFA-Y-120 CYCLOTRON. N. Martalogu and E. Trutia (Inst. of Atomic Physics, Bucharest). Acad. rep. populare Romine, inst. fiz. atomică și Inst. fiz., Studii cercetări fiz., 11: 1059-65(1960). (In Rumanian)

In order to determine the proton energies on the basis of the resonance relationships of the IFA cyclotron's beam, a precise method was developed for calculating the energy of the protons from their path in air and the energy scattering from the difference between the theoretical value of an initially monoenergetic beam and the experimentally determined scattering data. The mean free path value was obtained from the ionization produced in air at a known distance. As the cyclotron beam current could not be kept sufficiently constant the relative specific ionization was measured by means of 2 ionization chambers. The stopping power of materials was determined by interposing 7 Al foils with thicknesses ranging from 2.64 to 14.25 and 3 mica foils with thicknesses from 3.42 to 5.25 mg/cm² in the beam, using the Bragg curves for the calculations. The energy of the beam was found to be $E = 5.983 \pm 7.94 \cdot 10^{-3}$ Mev, and the energy scattering $(\Delta E/E) = 1.003 \cdot 10^{-2} = 1\%$. (TTT)

30090 AN ELECTROSTATIC GENERATOR WITH A ROTATING CYLINDER AND HYDROGEN INSULATION. N. J. (Zh.) Felici (Université, Grenoble, France). Atomnaya Energ., 11: 140-52(Aug. 1961).

It had been shown mathematically that the maximum power attainable in an electrostatic generator is proportional to the square of the dielectric strength of the gaseous insulator. Power on the order of a few kilowatts could be produced by a sectored generator if the problems of commutation and arcing across the gap could be solved. Replacement of multi-disc construction by the simpler and stronger cylindrical construction is a step in the right direction, since commutation can be effected by ionizing a compressed gas such as hydrogen which surrounds the cylinder. Since the mobility of ions in compressed hydrogen is high, it was found that relatively large currents can be obtained in an electrostatic generator operating in compressed hydrogen, if the gap between the electrodes producing the corona and the surface of the rotating cylinder is very small (on the order of 0.1 to 0.3 mm). The upper limit of the power of a single generator with a 40 to 50 cm plastic rotor is 30 to 50 kilowatts with a maximum voltage of 900 to 1200 kilowatts. The range of power and voltage can be extended considerably by hooking up separate generators in series or in parallel. Electronic circuits can be readily adapted to control the operation of the electrostatic generators. The characteristics of several compact models of these cylindrical electrostatic generators are described. The voltage varies from 80 to 600 kilovolts, the current from 0.3 to 40 milliamps, and the useful power from 20 to 3200 watts. These generators are used in teletherapy,

electron microscopes, neutron generators and electrostatic particle accelerators. (TTT)

30091 CURRENT LOAD OF THE BUNCHER IN A LINEAR ACCELERATOR. G. I. Zhileiko. Atomnaya Energ., 11: 181-2(Aug. 1961). (In Russian)

The main problem in designing a disk-loaded waveguide is that of finding the relation between the geometry of the diaphragms of the waveguide, and the length of the waveguide. This problem reduces to one of finding the change in dimensions of the diaphragms along the waveguide which will produce maximum particle bunching. It is necessary to take into account the effect of a large current on the decrease in amplitude of the traveling wave. A method which gives an approximate relationship between the wave propagation in a waveguide $\gamma = \sqrt{(\omega/v_p)^2 - (\omega/c)^2}$ versus the longitudinal length z for a waveguide with a variable phase velocity is presented. Current loading of the beam and losses to the wall are taken into account. On finding γ as a function of z , it is easy to determine the length of the waveguide, the particle current, the power of the generator, the accelerating voltage and the waveguide losses to the walls. (TTT)

30092 PARTICLE ACCELERATORS TO-DAY AND THEIR FUTURE. Toshio Kivagaki (Tohoku Univ., Sendai). Genshiryoku Kôgyô, 6: No. 4, 23-8(Apr. 1960). (In Japanese)

Progress in accelerator research is reported, with discussion of the various high-energy machines in existence in the world and the upper energy limits for these machines. Novel ideas for high-energy acceleration are described. The maximum energy obtained is graphically represented as function of time for 1932 to 1960. From the economic viewpoint, the following maximum energy limits are established: 6 Bev for the electron synchrotron; 20 to 45 Bev for the electron linear accelerator and 1000 Bev for the proton synchrotron. The following recently developed concepts are described: strong-focus proton synchrotron with high repetition; a similar machine with air-core magnet; fixed-field alternating gradient; scanning-field alternating gradient; colliding-beam accelerator; and the cascade accelerator. (TTT)

30093 PRODUCTION OF MAGNETIC FIELDS FOR STRONG FOCUSING, BY MEANS OF NONFERROUS COILS. J.-C. Schnuriger (Commissariat à l'Énergie Atomique, Paris). J. phys. radium, 22: Suppl. to No. 2, 68A-9A(1961). (CEA-1732). (In French)

A method is developed for calculating the magnetic field of a rectilinear conductor with a cross section of any given shape, which gives the potential vector in the form of a series of "multipolar" magnetic fields. This method is applied to the calculation of nonferrous coils producing the magnetic fields used in particle optics; deflection field, fields used in strong focussing (quadrupolar, hexapolar, octopolar, and those of the alternating-gradient synchrotron). An example shows that a quadrupolar nonferrous lens of constant current density may be obtained, of which the first sign of nonlinearity in the field is of the ninth order. (auth)

30094 PRACTICAL APPLICATION OF THE DEFOCALIZING INFLUENCE ON THE SPACE CHARGE. APPLICATION TO THE CASE OF RELATIVISTIC ELECTRON BEAMS. Albert Septier (Faculté des Sciences, Paris). J. phys. radium, 22: Suppl. to No. 6, 79A-82A(June 1961). (In French)

Using the equation of motion of a relativistic particle

situated on the surface of the beam, some formulas are obtained along with a chart permitting calculation, for any initial conditions, of the radius of the beam at a point on the axis of a drift space. The method is applied here to electron beams of 2 and 100 Mev. (auth)

30095 DISSOCIATION OF H_2^+ IONS BY A MAGNETIC FIELD. Selig Kaplan, George A. Paulikas, and Robert V. Pyle (Univ. of California, Berkeley). Phys. Rev. Letters, 7: 96-7 (Aug. 1, 1961). (UCRL-9763)

The dissociation of H_2^+ and H_3^+ ions by a magnetic field is reported. The ions, at energies of 10 Mev/nucleon, are passed through a magnetic field of up to about 19 kgauss. The field has enough strength to dissociate the $v = 17$ vibrational state, but not the $v = 16$ state. (T.F.H.)

30096 METHOD OF CHARGED PARTICLE INJECTION INTO MAGNETIC FIELD. E. M. Moroz (Inst. of Physics, Academy of Sciences, USSR). Priory i Tekh. Ekspt., 6: No. 1, 16-17 (Jan.-Feb. 1961). (In Russian)

A method, based on the Cherenkov effect, is suggested for injecting charged particles into a constant magnetic field without disturbing previously accumulated particles. The method can be applied in accumulating electrons up to several Mev. (R.V.J.)

30097 PROTON BEAMS OF VARIOUS ENERGIES INSIDE A MEAN ENERGY SYNCHROCYCLOTRON. S. S. Vasil'ev, V. V. Komarov, G. V. Koshelyaev, and A. M. Popova (Moscow State Univ.). Priory i Tekh. Ekspt., 6: No. 1, 17-18 (Jan.-Feb. 1961). (In Russian)

A copper 40° wedge-shaped target was designed for producing proton beams with various energies for studying nuclear reactions in a 30-Mev, 120-cm synchrocyclotron. Diaphragms with 3 mm clearance produced 9 proton beams with 7.5 to 30 Mev energies. Moreover, with diminishing proton energy the channel width also diminished. The protons were incident on photoplates at 6° . A uniform distribution of intensities in the channels permitted simultaneous exposure to various energies. (R.V.J.)

30098 ON ACCUMULATOR INJECTOR FOR SYNCHROTRONS. A. A. Kolomenskii (Inst. of Physics, Academy of Sciences, USSR). Priory i Tekh. Ekspt., 6: No. 1, 19 (Jan.-Feb. 1961). (In Russian)

An increase in injected and accelerated beam intensity is achieved at the expense of periodically accumulating protons in a special magnetic accumulator. (R.V.J.)

30099 HIGH-CURRENT GAS TARGET CHAMBER. N. A. Skakun and A. G. Strashinskii (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Priory i Tekh. Ekspt., 6: No. 1, 179 (Jan.-Feb. 1961). (In Russian)

A device capable of handling several tens of μ a of 2-Mev protons incident on a gas target is described. (R.V.J.)

30100 BLOCKING GAS TARGETS. N. A. Skakun and A. G. Strashinskii (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Priory i Tekh. Ekspt., 6: No. 1, 180 (Jan.-Feb. 1961). (In Russian)

A device is suggested for blocking gas seepage into accelerator in case of foil rupture. (R.V.J.)

30101 DUTY CYCLE IMPROVEMENT ON THE HARVARD SYNCHROCYCLOTRON. J. Lefrançois (Harvard Univ., Cambridge, Mass.). Rev. Sci. Instr., 32: 986-8 (Aug. 1961).

The frequency modulation of the Harvard synchrocyclotron was changed by redesigning the rotating condenser. Frequency curves and tooth shapes are presented graphi-

cally. Peak beam intensity was reduced while keeping average intensity constant. Dead time losses and random coincidence events which depend on the square of the beam intensity were reduced; the average rate of nuclear events, which depends on the average beam intensity, was unchanged. (L.N.N.)

30102 CALCULATIONS OF PARAMETRIC AMPLIFICATION OF AN ELECTRON BEAM WITH A GIVEN PUMPING FIELD. N. T. Kutsova and V. P. Martynov. Vestnik Moskov. Univ., Ser. III, 16: No. 1, 16-21 (Jan.-Feb. 1961). (In Russian)

An analysis is made of the parametric interactions of an electron beam modulated to the rate and density of ω current frequency with a pumping field frequency of 2ω . The approximation of a given field varying in time with 2ω is used in calculating the electron density and first harmonics expressing the amplified signal. It is shown that parametric amplification is a function of the pumping field amplitude and the initial phase relations between the pumping field and the accelerating signal. Considerations of space charge result in beam regrouping and a diminishing of the first harmonics of current. (tr-auth)

30103 STUDY OF MAGNETIC PROPERTIES OF PLASMA BEHIND THE FRONT OF A STRONG SHOCK WAVE. K. D. Sinelnikov, B. G. Safronov, Yu. S. Azovskii, G. G. Aseev, and V. S. Voitsenya (Khar'kov Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zhur. Tekh. Fiz., 31: 893-8 (Aug. 1961). (In Russian)

Studies were made of the currents in plasma behind a shock front at Mach 30 to 50 in a nonuniform axially-symmetric magnetic field of 400 gauss. Current magnitudes were determined as functions of magnetic field intensity and shock front velocity. The feasibility of the method for determining conductivity and temperature behind a strong shock wave ($m > 20$) was analyzed. Signals were found for successive shock waves, and polarization was measured behind shock waves in transverse fields up to 2000 gauss. (R.V.J.)

30104 THE CALCULATION OF ACCELERATING VOLTAGE FOR THE VARIABLE ENERGY CYCLOTRON. E. M. Moroz (Lebedev Inst. of Physics, Moscow). Zhur. Tekh. Fiz., 31: 916-22 (Aug. 1961). (In Russian)

Formulas are derived for calculating the high-frequency voltage amplitudes on the dee of a cyclotron with periodic magnetic field. (tr-auth)

Plasma Physics and Thermonuclear Processes

30105 (AD-254895) STUDY OF ELECTROMAGNETIC INTERACTIONS IN PLASMAS. Report No. 4. Fourth Quarterly Progress Report, October 1, 1960 to December 31, 1960. R. W. Gould and D. G. Dow (California Inst. of Tech., Pasadena. Electron Tube and Microwave Lab.). Contract DA 36-039 SC-85317. 11p.

Progress is reported on the cyclotron orbit plasma oscillator tube. A dispersion relation is obtained for the oscillations caused by the interaction between an electron beam and a nonuniform plasma, for the case in which the plasma's electron density changes very slowly in the direction of propagation of the oscillations. A study of Cs plasmas for use in microwave interaction experiments is initiated. Preliminary probe measurements of a Cs plasma tube are reported. (T.F.H.)

30106 (AFCRL-370) THE EFFECT OF THERMAL SPREAD ON THE TWO-STREAM RF GAIN FROM A NEUTRAL PLASMA BEAM. Technical Report No. 104-6. B. Hoeks (Stanford Univ., Calif. Electron Devices Lab.). Apr. 21, 1961. Contract AF19(604)-5480. 37p.

When plasma ions and electrons are accelerated in the same direction to different velocities, r-f signals are amplified along the plasma. Since the thermal velocity spread of the particles makes the imparted velocity difference less pronounced, the observed gain should be less than that predicted by the simple theory for "cold" streams. Calculations are presented that verify this reduction. Typically, the optimum gain is reduced to two-thirds of the "cold" value for a random electron velocity of about 10% of the relative drift velocity. The plasma equations are linearized, and it is assumed that the plasma is nearly electrically neutral, that hydrogen ions are used, that the thermal ion velocity is small compared with the ion drift velocity, that the frequencies considered are relatively small, and that the electron drift velocity is only slightly larger than the ion drift velocity. Below certain values of thermal spread, the gain passes through a maximum as the frequency is varied. As the thermal spread increases, the frequency at which this optimum occurs decreases. The gain disappears completely when the thermal velocities become very large compared with the relative drift velocity. (auth)

30107 (AFCRL-371) THE FREQUENCY OF NON-LINEAR PLASMA OSCILLATIONS. Technical Report No. 104-7. H. Derfler (Stanford Univ., Calif. Electron Devices Lab.). May 10, 1961. Contract AF19(604)-5480. 14p.

The frequency of plane standing waves of electrons moving through a background of infinitely heavy ions is found to be strictly independent of amplitude, as long as the electron velocity is a unique function of position. The frequencies of spherical and cylindrical plasma oscillations do, however, depend upon the amplitude of the oscillation. Thus any phase relationship between electrons is eventually destroyed, and the electron velocity becomes multivalued. Therefore steady free oscillations do not persist even in a cold plasma. (auth)

30108 (AFCRL-559) STRONG PLASMA SHOCK WAVES AND EXCITATION OF PLASMA OSCILLATIONS. Joachim Kölbl (Hanover (City)). Technische Hochschule. Institut für Theoretische Physik). Sept. 15, 1960. Contract AF61(052)-161. 57p.

Very strong shock waves in fully ionized plasmas are theoretically investigated by hydrodynamical methods. All essential effects of entropy generation, the distribution of density, and temperatures of ions and electrons are computed and it is found that these temperatures differ by several orders of magnitude within the shock because of an electron temperature and pressure wave ahead of the density jump. Plasma oscillations are excited ahead of the shock front, if the front velocity transgresses the electron sound velocity, leading thus to an instability of the shock structure. (auth)

30109 (AFOSR-1272) RADIATION BY PLASMA OSCILLATIONS INCIDENT ON A DENSITY DISCONTINUITY. D. A. Tidman and J. M. Boyd (Maryland. Univ., College Park). July 1961. Contract AF18(600)-1315. 25p. (BN-252)

The electromagnetic radiation produced by plasma oscillations propagating across a density discontinuity is calculated, and the boundary conditions applied in the process are discussed. (auth)

culated, and the boundary conditions applied in the process are discussed. (auth)

30110 (AFOSR-TN-60-1147) MAGNETOHYDRODYNAMIC SHOCK WAVES. Jack Davis (Northeastern Univ., Boston). May 1960. Contract AF49(638)-555. 63p.

An analysis of the mathematical structure of theory related to the interaction of magnetic fields with conducting compressible fluids is presented. Non-relativistic magnetohydrodynamics for these fluids is examined along with the non-relativistic propagation of plane perpendicular magnetohydrodynamic shock waves. The effect of thermal diffusion on the non-relativistic propagation of plane normal magnetohydrodynamic shock waves in a mixture of two completely ionized gases is also investigated. (J.R.D.)

30111 (CLM-R4) THE STABILITY OF A PLASMA SUPPORTED BY A MAGNETIC FIELD AGAINST A GRAVITATIONAL POTENTIAL. R. A. Cowley (United Kingdom Atomic Energy Authority. Research Group. Culham Lab., Culham, Oxfordshire, England). July 1961. 40p.

The instability caused by gravity in an ideal plasma is investigated both for the special case of a planar field and for the case of a shear field. Stability criteria are deduced using the magnetohydrodynamic equations, and an example is found that can be made to satisfy the criteria. For cases in which instabilities occur, upper limits to the growth rates are deduced. (auth)

30112 (CLM-R7) TOROIDAL DISCHARGE CONFIGURATIONS OBTAINED FROM MAGNETIC PROBE MEASUREMENTS. E. A. Witalis (United Kingdom Atomic Energy Authority. Research Group. Culham Lab., Culham, Oxfordshire, England). July 1961. 46p.

Low pressure argon discharges in the MK IV torus were studied by magnetic probe technique during the early part of the discharge when the results so given are reproducible. A method of analysis is presented by which the experimental results may be compared with those predicted by two theoretical models. It is shown that neither model is wholly satisfactory in this case. Several types of discharge are found, one of which corresponds to a "rigid" behavior of the current helix which occurs just before the onset of irreproducibility of the magnetic probe signals. (auth)

30113 (ML-817) OSCILLATIONS AND NOISE IN LOW-PRESSURE DC DISCHARGES. Scientific Report No. 33. F. W. Crawford and G. S. Kino (Stanford Univ., Calif. Microwave Lab.). June 1961. Contracts AT(04-3)-326 and AF19(604)-1930. 94p. (AFCRL-564).

Oscillations and fluctuations which were observed to occur either spontaneously, or as a result of deliberate excitation, in low-pressure, hot-cathode plasmas are considered. Experimental observations on high and low frequency effects occurring spontaneously are discussed, and speculations are made on the possible generation mechanisms. In many cases, theories of these mechanisms were treated in experiments involving deliberate excitation of oscillations, and comparisons were made where relevant. For device applications, and to relieve the difficulties which occur in quantitative experiments in plasma physics, it is important that the sources of spontaneous oscillations should be understood and suppressed if possible. A discussion of work which was carried out to reduce these effects and some suggestions for further lines of attack on the problems are included. (auth)

30114 (NASA-TR-R-114) A THEORETICAL TREATMENT OF THE STEADY-FLOW, LINEAR, CROSSED-FIELD, DIRECT-CURRENT PLASMA ACCELERATOR

FOR INVISCID, ADIABATIC, ISOTHERMAL, CONSTANT-AREA FLOW. George P. Wood, Arlen F. Carter, Hubert K. Lintz, and J. Byron Pennington (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.). 1961. 42p.

The theory is developed from the individual equations of motion of the three components of the plasma. The effect of the ion cyclotron angle $\omega\tau$, which is the product of the ion cyclotron frequency and the ion mean free time between collisions with neutral particles and which is proportional to the axial component of the ion slip velocity, on both Joule heating rate and accelerator length is included in the results and is shown to be small only for values of about 10^{-3} radian or less. (auth)

30115 (NP-10668) MAGNETOHYDRODYNAMICS AND ENERGY CONVERSION. Technical Progress Report No. 3 for Period Ending May 31, 1961. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). June 15, 1961. Contract AF33(616)-7624. 20p.

This report was included as a section of Quarterly Progress Report No. 62, July 15, 1961, of the Research Laboratory of Electronics.

Magnetohydrodynamic A-C Generator with Gas Losses. Haus' analysis of an a-c generator coupled with an electric circuit is extended to the case of real gases with small losses. The results, calculated for some gases, indicate that for combustion gases the generator size is too large, while for Ar and H₂ laboratory-size generators are possible. Magnetic Reflection of a Shock-Produced Plasma. Experimental results are given for the reflection of a plasma in a shock tube by a magnetic coil, along with a theoretical treatment. The results indicate that the reflected shock is produced by the interaction of the radial field component with the plasma and that the gas conductivity is increased by the compression. Decaying Magneto-fluiddynamic Flows. Wiener's calculus of random functions is used to analyze decaying hydromagnetic flows, and the results show that an isotropic field of turbulence decays to an axisymmetric field in a magnetic field. Fuel Cells. An experimental apparatus is described for resolving the question of whether the electrode reactions in a gaseous fuel cell occur at the three-phase or two-phase boundary. (D.L.C.)

30116 (NP-10673) PITCH ANGLE DIFFUSION IN A MAGNETIC MIRROR GEOMETRY. Technical Report 220. R. C. Wentworth and W. M. MacDonald. (Maryland. Univ., College Park). July 1961. 13p.

The diffusion in pitch angle produced by Coulomb scattering of charged particles in a magnetic mirror is studied. The diffusion equation for the scattering is found by considering the random motion of particles on a sphere in momentum space. The effects of scattering at various sections of the geometry are considered. The treatment is evolved for the radiation belts of the earth, but may be extended to any magnetic mirror geometry. (T.F.H.)

30117 (ORNL-3170) ELECTROSTATIC ION-CYCLOTRON PLASMA INSTABILITIES IN A TWO-FLUID HYDRODYNAMIC THEORY. Hermann K. Wimmel (Oak Ridge National Lab., Tenn.). Sept 1, 1961. Contract W-7405-eng-26. 30p.

A two-fluid hydrodynamic theory is found to describe certain electrostatic ion-cyclotron plasma instabilities in a semiquantitative way. The ions (electrons) are described by the first three (two) moment equations of the collisionless Boltzmann equation, implying zero electron temperature. Only purely longitudinal (electrostatic) oscillations

are considered. If the electron plasma frequency ω_p is greater than the ion cyclotron frequency Ω_c and if the ion pressure is sufficiently anisotropic, unstable oscillations occur with $|\text{Re}(\omega)| \approx \Omega_c$. Owing to the limitations of the model, only the cases in which the wavelength of the oscillation mode is large compared to the ion cyclotron radius can be treated. Instabilities at higher harmonics of the ion cyclotron frequency are also excluded. Quantitative agreement with the results for the infinite plasma is found only for \mathbf{k} (propagation vector) nearly parallel to \mathbf{B}^0 (magnetic field); otherwise, the present equations contain stabilizing extra terms not found in the rigorous theory. Estimates of the critical pressure anisotropy at which instability sets in are given. The critical anisotropy is smallest for the "resonance" case $\omega_p \approx \Omega_c$ with \mathbf{k} lying nearly parallel to \mathbf{B}^0 . Short-wavelength modes are less stable than long-wavelength modes. The two-fluid hydrodynamic model allows a pictorial understanding of the unstable oscillation modes and of the fact that geometric boundaries have little influence on the conditions for instability. (auth)

30118 (PAN-243/IX) THE METHOD OF SOLUTION OF THE NON-STATIONARY MOTIONS OF A PLASMA IN AN ELECTROMAGNETIC FIELD. A. Legatowicz (Polish Academy of Sciences. Inst. of Nuclear Research. Warsaw). June 1961. 11p.

A method is presented for solving the problem of non-stationary motions of a plasma in an external electromagnetic field. The transport equations for ions and electrons are assumed to be correct. These equations are simplified by the acceptance of certain other assumptions concerning the plasma parameters. The solution is found for the motions by applying an expansion in powers of a small parameter (on the order of v/c for electrons). Methods are given whereby the solution may be found to any desired order of approximation. (auth)

30119 (UCRL-6535) PROBES AND MAGNETIC PUMPING IN PLASMA (thesis). Laurence S. Hall (California. Univ., Livermore. Lawrence Radiation Lab.). July 19, 1961. Contract W-7405-eng-48. 71p.

Certain problems that arise in connection with the diagnostics and heating of fully ionized plasma were treated. The closely related theories of the plasma sheath and of electrostatic probes are reviewed. Certain misinterpretations which appeared in the literature were clarified and some corrections and extensions of the theory of the Langmuir probe are given. Particular attention was given to developing a practical method of determining the plasma parameters from the experimental measurements. The use of a saw-toothed time-varying magnetic field to provide reversible thermodynamic heating of a plasma by magnetic pumping is discussed. The efficiency was improved over that found in the more conventional use of sinusoidally varying fields, which provide only the irreversible heating guaranteed by the second law of thermodynamics. (auth)

30120 (USCEC-83-207) ELECTRIC CONDUCTIVITY OF A HIGH TEMPERATURE PLASMA TO A RADIO WAVE. Technical Note. Toyoki Koga (University of Southern California, Los Angeles. Engineering Center). July 1961. Contract AF 49(638)-831. 25p. (AFOSR-1184).

The effect of the temperature of a fully ionized plasma on its conductivity (C) in the presence of a radio wave is investigated, taking into consideration the finite wavelength of the radio wave. This finiteness has an effect on C , on the order of $kT/(ma^2)$, where T is the plasma temperature, m the electron mass, k the Boltzmann constant, and a the phase velocity of the wave. (auth)

30121 (AEC-tr-4791) ON THE POSSIBILITY OF THE DIRECTED INTRODUCTION OF DEUTERIUM AND TRITIUM IN NUCLEAR FUSION EXPERIMENTS. E. W. Becker, R. Klingelhöfer, and P. Lohse. Translated for Oak Ridge National Lab. from *Z. Naturforsch.*, 15a: 64-5(1960). 7p. (Includes original, 2p.).

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 14, Abstract no. 24950.

30122 (AEC-tr-4793) MILLIMETER WAVE DETERMINATION OF PLASMA ELECTRON DENSITY. E. Yahagi and E. Yamashita. Translated for Oak Ridge National Lab., Tenn., from *Denki Shikensho Iho*, 24: 925-39(1960). 49p. (Includes original, 15p.).

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 15, abstract no. 12328.

30123 (AFCRL-534) SURFACE WAVES ON THE BOUNDARY OF A PLASMA IN A MAGNETIC FIELD. M. A. Gintsburg. Translated from Trudy Nauch.-Issledovatel'. Inst. Zemnogo Magnetizma, Ionosfery i Rasprostraneniya Radiovoln, No. 17, 208-15(1960). 12p.

Surface waves on the interface between a plasma and an isotropic medium and at the interface between two gyrotropic media were investigated. Conditions for surface wave propagation were determined. Applications of these results to measurement of the tensor component of the electrical permeability of a plasma and for radiowave propagation in the ionosphere are discussed. (M.C.G.)

30124 PARTICLE DISTRIBUTION IN A CHARGED BEAM IN STORED SYSTEMS. V. K. Grishin. *Atomnaya Energ.*, 11: 183-4(Aug. 1961). (In Russian)

The problem of storage in high-current magnetic systems needed for achieving reactions in opposite beams, is connected with the space charge effect of the particles. In view of the interest of plasma effects in stored systems, the self-adjustment of the azimuthally non-homogeneous particle distribution and its stability were studied, deriving equations for determining the self-focussing non-homogeneous density distribution. It was found that the stability of a given configuration does not depend on the number of particles in the beam and on the average energy of the system but can be determined as a function of the canonic variable ψ . (TTT)

30125 MAGNETODYNAMIC OSCILLATIONS SYMMETRIC WITH RESPECT TO AN AXIS IN AN ELECTRICALLY CONDUCTING ISOTHERMAL ATMOSPHERE EXPOSED TO GRAVITATIONAL ACTION. Tino Zeuli. *Atti acad. sci. Torino. I. Classe sci. fis., mat. e nat.*, 95: 460-72(1960-61) (Pub. 1961). (In Italian)

The magnetodynamic oscillations symmetric with respect to the axis are studied for a plane gaseous layer, isothermal, of high electrical conductivity, immersed in a uniform magnetic field parallel to the axis of the layer. (tr-auth)

30126 THE ABSORPTIVITY SPECTRUM OF A UNIFORM, ANISOTROPIC PLASMA SLAB. I. P. French, G. G. Cloutier, and M. P. Bachynski (RCA Victor Co., Ltd., Montreal). *Can. J. Phys.*, 39: 1273-90(Sept. 1961).

Using a generalized formulation of Kirchhoff's law it is possible to relate the equilibrium electromagnetic radiation spectrum of a body to its absorptivity spectrum. The microwave absorptivity of a uniform anisotropic plasma slab to a normally incident electromagnetic wave is obtained by matching fields at the boundaries and is solved completely for the model chosen. The absorptivity spectrum of the plasma slab is computed for waves propagating parallel to an normal to an applied static magnetic

field for various electron densities, electron collision frequencies, and slab thicknesses. Peaks in the absorptivity spectrum occur around the edges of the stop-bands. In general, the absorptivity increases with slab thickness and collision frequency. The effect of internal reflections is included and gives rise to undulations in the absorptivity spectrum. (auth)

30127 THE CONSERVATION OF VORTICES AND CURRENTS IN MAGNETIC HYDRODYNAMICS. M. N. Kogan. *Doklady Akad. Nauk S.S.S.R.*, 139: 58-9(July 1, 1961). (In Russian)

In classical hydrodynamics, Thomson's theorem states that movement of a velocity over a closed liquid loop remains constant during the time of flow, or that the vortices move together with the particles of liquid. Although this theorem is not fulfilled in magnetic hydrodynamics, there is an analogous theorem which plays the same role. A small perturbation (that is, $V-V_0$ and $H-H_0$ are small, where V_0 and H_0 are the velocity and magnetic field vectors) is introduced into the flow of an incompressible fluid having an infinite electrical conduction. The vector H is replaced by the corresponding Alfvén velocity $A = H/\sqrt{4\pi\rho}$, where ρ is the density of the liquid. It is found that $\text{curl}(V+A)$ is displaced with respect to the liquid by a velocity $-A_0$ and $\text{curl}(V-A)$ is displaced by a velocity A_0 . In other words, in contrast to ordinary hydrodynamics, there are two possible directions for the movement of the vortices, and the vortices are not tied to the liquid. (TTT)

30128 STUDY OF PINCH-TYPE PLASMA. Miroru Okada (Osaka Univ.). *Genshiryoku Kōgyō*, 6: No. 2. 9-24 (Feb. 1960). (In Japanese)

A systematic study of plasma at very high temperatures has been in progress at the Osaka University since 1955. A current of more than $0.6 \cdot 10^6$ amp has been obtained in a linear discharge, using 40 parallel condenser banks, each of which had 15 kv and 160 μF and a 20 kw-sec pulse discharge equipment. In 1957 a 100 kw-sec (100 kv, 20 μF) apparatus was constructed, making it possible to reach $2.7 \cdot 10^6$ amp; a neutron yield of about 10^6 to 10^7 nsec was detected at the same time in the linear discharge pulse of deuterium. On the basis of the shrinkage velocity of the plasma, the kinetic temperature gain was estimated at more than $2 \cdot 10^6^\circ\text{K}$. Various pinch patterns were observed by static and high-speed streak cameras. A description of the dynamic behavior of plasma in the linear pulse discharge of N and A is also presented. (TTT)

30129 DIELECTRIC BREAKDOWN CONDITIONS IN THE MIRROR-TYPE AND THE INDUCTION PINCH MECHANISMS. Taijiro Uchida and Hisamitsu Yoshida (Nihon Univ., Tokyo). *Genshiryoku Kōgyō*, 6: No. 2, 15-19(Feb. 1960). (In Japanese)

The study group for fusion research, organized at the Nihon University developed an apparatus, details of which were given previously (*Nuclear Fusion Research* 2: 108 (1959)). The most recent results of the theoretical study are given, including a T-nt diagram, the mechanism of the pinch effect, equilibrium conditions in magnetohydrodynamics, effect of magnetic mirrors, and breakdown conditions of magnetic discharges. The experimental work reported includes the analysis of current and voltage by the high-speed streak camera, plasma vibrations, confinement by a magnetic field, use of photomultiplier systems and optical spectroscopic studies. Plans for more advanced study are also discussed. (TTT)

30130 PROPAGATION OF A SOLITARY WAVE ALONG A MAGNETIC FIELD IN A COLD COLLISION-FREE

PLASMA. P. G. Saffman (King's Coll., London). *J. Fluid Mech.*, 11: 16-20 (Aug. 1961).

Solitary hydromagnetic waves can propagate parallel to a uniform magnetic field in a cold collision-free plasma. These waves are exact solutions of the non-linear equations of motion except for the quasi-neutral approximation. The velocity of propagation lies in a range of values somewhat larger than the Alfvén velocity, and is of the order of 25 times the Alfvén velocity for hydrogen, the precise value depending upon the strength of the wave. Simple expressions exist for the velocities of the ions and electrons and the magnetic field inside the wave. The lines of force are spirals about the direction of propagation. The waves are symmetrical about their middle. The order of magnitude of their width is the geometric mean of the gyro-radius of the ions and electrons when moving with the Alfvén velocity. The maximum value of the magnetic field can be somewhat larger than the value away from the wave. (auth)

30131 END EFFECTS IN INVISCID FLOW IN A MAGNETOHYDRODYNAMIC CHANNEL. G. W. Sutton and A. W. Carlson (General Electric Co., Philadelphia). *J. Fluid Mech.*, 11: 121-32 (Aug. 1961).

The flow of an inviscid, incompressible electrical conducting fluid in a channel of constant rectangular cross-section is considered, when the flow enters a region which contains a magnetic field transverse to the flow and electrodes on opposite sides of the channel. This geometry is typical of a d-c induction pump or magnetohydrodynamic generator. The conducting fluid external to the magnetic field acts as a shunt and produces a non-uniform electric potential field and hence a non-uniform Lorentz force on the fluid, and causes the fluid velocity profile to be distorted. These effects are calculated theoretically for small magnetic Reynolds number and small magnetic interaction parameter. It is found that the velocity at the center-line of the channel is retarded and at the walls the velocity is accelerated. The fractional change of velocity at the wall is equal to approximately 0.44 times a modified magnetic interaction parameter. (auth)

30132 THE FORCE ON A SPHERE MOVING THROUGH A CONDUCTING FLUID IN THE PRESENCE OF A MAGNETIC FIELD. J. R. Reitz and L. L. Foldy (Case Inst. of Tech., Cleveland). *J. Fluid Mech.*, 11: 133-42 (Aug. 1961).

The force on a sphere moving through an inviscid, conducting fluid in the presence of a uniform magnetic field B_0 is calculated for the low-conductivity case where the hydrodynamic motion deviates only slightly from potential flow. The magnetic Reynolds number is assumed small. The force on the sphere is found to consist of both a drag and a deflective component which tends to orient its motion parallel to a magnetic field line; if the sphere's velocity is V , the force may be written $R = -AB_0^2 V + C(V \cdot B_0)B_0$, where the coefficients A and C depend on the conductivities of both sphere and fluid. The coefficients are evaluated by calculating the Joule dissipation for particular orientations of V relative to B_0 . In one case the force is also calculated directly from the perturbed pressure distribution in the fluid. In an analogous way, a spinning sphere in a conducting fluid experiences both resistive and gyroscopic torques. (auth)

30133 EXPERIMENTS ON THE COMPRESSION OF PLASMA IN CUSP GEOMETRY. T. K. Allen and R. J. Bickerton (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *Nature*, 191: 794-5 (Aug. 19, 1961).

The possibility of containing plasma by cusp-shaped magnetic fields is discussed. An apparatus is described which was built to investigate this configuration experimentally. Shock pre-heated plasma is compressed by a rising cusped magnetic field. A diagram is presented of the discharge vessel and associated magnetic field coils. The effect of the rising cusp field on the pre-heated plasma was studied with a framing camera. Examples of the observed phenomena are shown and discussed. (C.H.)

30134 A NEW 'WEDGE' TYPE INSTABILITY OBSERVED IN A 'THETA' PINCH. J. K. Wright, R. D. Medford, J. D. Herbert, and R. C. Pottinger (Atomic Weapons Research Establishment, Foulness, Southend-on-Sea, Eng.). *Nature*, 191: 1054-6 (Sept. 9, 1961).

The phenomena of trapped magnetic fields were observed in theta pinches during the first half-cycle of the discharge. The parameters of the experiment were such that a cylindrically converging shock wave was obtained on the first half-cycle with trapped magnetic field parallel to the driving field. Photographs of the discharge show bright radial wedges with less luminous plasma filling their interstices. The number of wedges seems to be determined by the irregularities in the system since it can be varied by deliberately introducing irregularities in the external conductors. The effect of reducing the trapped magnetic field by a considerable factor was also studied. Next a reversed trapped magnetic field was produced during the first half-cycle of the discharge. When the externally produced field was at a maximum, the theta discharge was initiated and the plasma produced had a reversed trapped magnetic field. The experimental evidence suggests that the radial wedges are only formed when there is a trapped magnetic field in the same direction as the driving field when the azimuthal currents on the shock front and the current sheet have opposite directions of rotation. (P.C.H.)

30135 CORRELATION OF ELECTRIC FIELD IN A PLASMA. I. Fidone (Groupe de Recherches de l'Association Euratom-CEA, Fontenay aux Roses, France). *Nuovo cimento* (10), 20: 1219-23 (June 16, 1961). (In French)

Recently Taylor applied the generalized Nyquist theorem to the resistivity of a plasma. The fiction constant is expressed by $\mu = Z^2 e^2 / kT \int_0^\infty C(\tau) d\tau$ where $C(\tau) = [E_x(t) E_x(t + \tau)]$ is a function of temporal correlation of the electric field fluctuant $E(t)$ created by the electrons. E_x is one component of E and the average considered is the aggregate average. In calculating the average, Taylor assumed the electrons to be independent of each other. An attempt is made here to obtain a better approximation by introducing the spatial correlation effect of electrons. (T.R.H.)

30136 RELATIVISTIC PINCH EFFECT. T. T. Vescan (Univ. of Iasi). *Nuovo cimento* (10), 21: 205-12 (July 16, 1961). (In French)

In considering the relativistic metric which generalizes, for example, the metric of the turning disk, one can study using a technique described earlier the extremals and the dynamic attached to this metric. In emphasizing that W/m_0 is the expression for potential energy of a unit of mass, that is $W = -m_0 V$, m_0 being the rest mass of the particle moving in the field represented, from the classical point of view, by the potential $V(r)$, one obtains the approximate expression for the relativistic electrodynamic force, a force of "pondero-motrice" nature, acting perpendicularly to the axis of the cylinder upon a charge of plasma found within a cylindrical device. From the expression for the rate of the charge one can suppose that $r = v$, $|W| \ll mc^2$ and $|v| < c$. Without the classic term in W' , the expres-

sions for the force contain then a term in W/r which represents a corrective force, attractive or repulsive according to the sign of the charge, which can contribute to the contraction of the current, to the production of the pinch effect. It also describes, at the same time, the case of toroidal installations. (tr-auth)

30137 SHOCK CURVATURE DUE TO BOUNDARY-LAYER EFFECTS IN A SHOCK TUBE. R. A. Hartunian (Aerospace Corp., Los Angeles). *Phys. Fluids*, 4: 1059-63(Sept. 1961).

A two-dimensional, linearized treatment, including real gas effects, of shock curvature in a shock tube is presented. An expression for shock shape as a function of shock Mach number and initial pressure of the test gas is presented. The results are compared with the available experimental data obtained in argon at low shock strengths and in air at high shock Mach numbers. Within the scatter of the data in the latter experiments, there is relatively good agreement with theory, while theory falls approximately $30 \pm 10\%$ above the data in argon. Some of this disagreement is attributed to application of the two-dimensional theoretical result to axisymmetric shock tubes of finite dimensions used in the experiments. (auth)

30138 DIFFUSION IN A SLIGHTLY IONIZED GAS WITH APPLICATION TO EFFUSION FROM A SHOCK TUBE.

Bradford Sturtevant (California Inst. of Tech., Pasadena). *Phys. Fluids*, 4: 1064-73(Sept. 1961).

A sampling technique for measuring the diffusive flux of charged particles from an ionized gas to a cold wall by measuring the effusive electrical current through a small orifice in the wall was used to study slightly ionized argon behind reflected shock waves. The technique is described and the transient diffusion process upon which it depends is considered in some detail. Computations based on a simple one-dimensional isothermal charge diffusion model illustrate the features and give the result that the effect of the electric body forces is generally greater on the ions and less on the electrons than originally expected. These results are used in an approximation to the nonisothermal problem to give a relation between the measured effusive current and the ion density in the hot gas. Preliminary observations of the dependence of ion density on time and temperature in the initial stages of ionization relaxation are reported. Simple considerations of the chemical kinetics indicate that for the portion of the process observed (degree of ionization about 10^{-5} times the equilibrium value) the ionization of argon results from a complicated series of consecutive reactions. (auth)

30139 MAGNETOHYDRODYNAMIC RESULTS FOR HIGHLY DISSOCIATED AND IONIZED AIR PLASMA. H. T. Nagamatsu (General Electric Research Lab., Schenectady, N. Y. and Rensselaer Polytechnic Inst., Troy, N. Y.) and R. E. Sheer, Jr. *Phys. Fluids*, 4: 1073-84(Sept. 1961).

An investigation of air plasma moving through a constant (2,300 gauss) transverse magnetic field was conducted in a shock tube. As the plasma traveled through the field, an electromotive force was produced in the plasma. Two diametrically opposite, $\frac{1}{2}$ -in. diameter, copper electrodes were used to measure this potential. The shock Mach number varied from 10 to 32 with corresponding equilibrium plasma temperatures at 3,600° to 11,000°K. At Mach 30 the observed potential across the electrodes, with a 1-meg external load, was 236 v, which agreed with the theoretical value, but at lower Mach numbers the observed potentials were much lower than theory. By varying the external load for a shock Mach number of 30, the current from the plasma varied from nearly zero to 115 amp. This high current was

extracted from the copper electrodes at nearly room temperature. The observed potential decreased linearly with increasing current indicating a nearly constant plasma resistance. For this resistance the electrical conductivity was calculated and was much less than the theoretical prediction. The maximum power extracted from the plasma was 7.8 kw with an external load of 1.85 ohms. (auth)

30140 SHOCK WAVE PHENOMENA IN COAXIAL PLASMA GUNS. C. T. Chang (Royal Inst. of Tech., Stockholm). *Phys. Fluids*, 4: 1085-96(Sept. 1961).

In a plasma gun (or a magnetically driven shock tube) shocks are usually obscured by a luminous front. Using a reflection technique and a pressure probe, the existence of a shock wave is confirmed experimentally. For weak shocks the luminous front lags definitely behind the shock front. For strong shocks there is an indication that the two fronts might coincide. The reflection technique also indicates the presence of a possible relaxation process. Since the amount of energy loss to the wall is not certain at present, no attempt is made to inquire further in the detail of the process. A simple analytical model is formulated, from which the shock speed is related to the discharge conditions. Some of the analytical results are compared with those obtained experimentally. (auth)

30141 LOW MACH NUMBER MAGNETIC COMPRESSION WAVES IN A COLLISION-FREE PLASMA. P. L. Auer, H. Hurwitz, Jr., and R. W. Kilb (General Electric Research Lab., Schenectady, N. Y.). *Phys. Fluids*, 4: 1105-21(Sept. 1961).

The development of a strong hydromagnetic disturbance traveling perpendicular to an initially uniform magnetic field in a cold plasma is investigated by numerical integration of the equations of motion. The disturbance is driven by an electric field applied at a fixed plane surface which coincides with the initial boundary of the plasma. If the Mach number of the resulting disturbance is less than two, no crossing of particle orbits occurs. The disturbance then consists of a growing train of almost independent hydromagnetic pulses progressing into the undisturbed plasma at a speed somewhat in excess of the shock velocity which would be calculated from classical theory. The magnitudes of the vacuum magnetic field and the vacuum-plasma interface velocity are, however, almost identical to the predictions of classical theory. These results, as well as the observed pulse spacing, can be understood in terms of a two-region model of the disturbed portion of the plasma together with the assumption that the pulses are accelerated by mutual interaction until their spacing substantially exceeds their width. (auth)

30142 ON A VARIATIONAL PRINCIPLE FOR A CLASSICAL PLASMA. S. Gartenhaus (Purdue Univ., Lafayette, Ind.). *Phys. Fluids*, 4: 1122-30(Sept. 1961).

A time-dependent version of the Hartree-Fock method is set up for a classical system, by making use of the formal similarity between Liouville's equation for such a system and the Schrödinger equation. The use of a product trial function in the resultant variational principle produces, for a plasma, the collisionless Boltzmann equation. A second application is made to a system for which short-range correlations are small but not negligible. It is found that regardless of the range of the interparticle forces and the magnitude of the density, equilibrium is described only by a Maxwellian velocity distribution. (auth)

30143 EXPERIMENTS ON ION CYCLOTRON WAVES. W. M. Hooke, F. H. Tenney, M. H. Brennan, H. M. Hill, Jr., and T. H. Stix (Princeton Univ., N. J.). *Phys. Fluids*, 4: 1131-41(Sept. 1961). (MATT-65)

Experiments were performed on the generation of ion cyclotron waves and their propagation into a magnetic beach. The experiments were carried out on the B-66 machine, which is currently a magnetic mirror device. Studies of the production of neutrons have provided evidence for the absorption of the energy of these waves via ion cyclotron damping. Microwave phase-shift measurements are completed, and the addition of electron density completes the list of parameters required for direct comparison of experimental and theoretical dispersion relations. The experimental data yield a smooth monotonic relation between density and frequency which is qualitatively similar to that predicted by theory. There are, however, unexplained quantitative differences. Wave propagation into the magnetic beach region was observed with a single turn rf magnetic probe. The variation of the amplitude of these waves in the magnetic beach is in qualitative agreement with the theory of ion cyclotron wave propagation and cyclotron damping. (auth)

30144 DIFFUSION OF PLASMA IONS ACROSS A MAGNETIC FIELD. J. B. Taylor (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). *Phys. Fluids*, 4: 1142-5 (Sept. 1961).

Earlier work on the application of the correlation function of the electric field in a plasma is extended to the problem of diffusion of ions across a magnetic field. It is shown that the flux can be considered in three parts; one depends on the electric field correlation function and the others on the dynamic friction, which is related to the correlation function by Nyquist's theorem. When the ion and electron temperatures are unequal the present result differs from that obtained by a Chapman-Enskog type analysis of the transport equation and the interpretation of this difference is discussed. Some consequences of the diffusion formula, as it concerns impurities, are noted. (auth)

30145 STATIONARY STATE OF A HIGH-TEMPERATURE GAS-INSULATED PLASMA COLUMN. Carl-Gunne Fälthammar (Royal Inst. of Tech., Stockholm). *Phys. Fluids*, 4: 1145-51 (Sept. 1961).

On the basis of a simplified theoretical model an analysis is given of the stationary state of a cylindrical column of fully ionized high-pressure plasma, which is heated by an axial current and cooled by heat conduction in the radial direction across the self-magnetic field of the current. The radial distributions of current, magnetic field, temperature, pressure, and density are calculated and discussed. The power needed to maintain a stationary state at very high temperatures is found to be moderate. The relative importance of radiation losses is considered and found to be small in a certain range of parameters. (auth)

30146 TOROIDAL HIGH-PRESSURE DISCHARGE EXPERIMENT. Erik A. Smårs and Rolf B. Johansson (Royal Inst. of Tech., Stockholm). *Phys. Fluids*, 4: 1151-5 (Sept. 1961).

A toroidal gas discharge experiment in the pressure range 1 to 400 torr was performed to test the idea of insulating a hot plasma with a high-density magnetized gas. It is found that it is possible to create an electrodeless circular arc discharge surrounded by cool gas. The surrounding high-density gas tends to stabilize the plasma ring and protects the plasma from contamination by wall impurities. (auth)

30147 INTERACTION OF LOW-FREQUENCY ELECTROMAGNETIC WAVES WITH A PLASMA. Donald L. Turcotte and Gerald Schubert (Cornell Univ., Ithaca, N. Y.). *Phys. Fluids*, 4: 1156-61 (Sept. 1961).

The interaction of a low-frequency electromagnetic wave with a semi-infinite plasma is considered. The single-fluid equations of magneto-gas dynamics are linearized in the presence of a strong, uniform, steady magnetic field. Solutions are obtained for both normal incidence and parallel propagation of the electromagnetic wave. In both cases the strong, steady magnetic field is parallel to the interface and the magnetic component of the incident wave has the same direction. In the examples considered, the parameter $\mu_0^2 \sigma_0 H_0^2 / \rho_0 \omega$ determines the interaction between electromagnetic and acoustic modes. With normal incidence an acoustic mode is excited if this parameter is of order one. In the case of parallel propagation an appreciable parallel velocity component is excited when the governing parameter is quite small. (auth)

30148 INTERACTION BETWEEN A RADIO WAVE AND A PLASMA. Toyoki Koga (Univ. of Southern California, Los Angeles). *Phys. Fluids*, 4: 1162-6 (Sept. 1961).

The interaction between a radio wave and a plasma is studied based on the Boltzmann equation for electrons. Collisions between electrons and heavy particles and the electric field caused by the group displacement of electrons are taken into account. The relation between the current density and the oscillating electric field is obtained. The solution is exact so far as the proposed Boltzmann equation for electrons is concerned. According to the result, the propagation of the radio wave in the plasma is investigated. As the electric field caused by the group displacement of electrons becomes negligibly weak, the results approach those obtained by Margenau. (auth)

30149 TIME LAG IN THE THERMALIZATION OF A FAST ION IN A PLASMA. H. L. Frisch (Bell Telephone Labs., Inc., Murray Hill, N. J.). *Phys. Fluids*, 4: 1167-71 (Sept. 1961).

The time lag in the thermalization of the spherical mean speed of a fast ion injected into a plasma is defined and computed without solving the Fokker-Planck equation governing the distribution in speed. The time lag and certain related, recursively computable, time moments can serve as local measures of the rate of evolution of the Maxwellian distribution from an initial one, particularly for large values of the speed. Numerical computations of the time lag are presented for a fully ionized deuterium plasma for two initial conditions. Certain natural extensions of the time lag are briefly mentioned. (auth)

30150 MOLECULAR BEAM FOR THE STUDY OF HIGH-TEMPERATURE-GAS COLLISION PROCESSES. George T. Skinner (Cornell Aeronautical Lab., Inc., Buffalo). *Phys. Fluids*, 4: 1172-6 (Sept. 1961).

A high-intensity molecular beam is described, in which a tailored-interface shock tube is used as the gas source. The purpose of the apparatus is to extend molecular beam techniques into the 1 to 10 eV per particle range, in order to study collision processes in high-temperature gases. The principles of the apparatus are discussed. Experimental intensity profiles agree with the predicted profiles. A 0.7-eV nitrogen beam was produced in experiments which were designed to determine whether high-intensity high-energy beams could be obtained when the stagnation temperature of the gas is an order of magnitude higher than the apparatus temperature. (auth)

30151 KELVIN-HELMHOLTZ INSTABILITY IN MEDIA OF VARIABLE DENSITY. Z. Alterman (Yerkes Observatory, Williams Bay, Wis.). *Phys. Fluids*, 4: 1177-9 (Sept. 1961).

The instability of two fluids separated by a horizontal

boundary and in relative horizontal motion is investigated in the case of densities varying exponentially with height. There is a striking similarity between the effects of density variation and of rotation on the onset of instability. Conditions for stability are given, and the effect of a superposed magnetic field is discussed. (auth)

30152 UNIFIED RHEOLOGICAL RELATION ON NON-NEWTONIAN FLUIDS. Chieh C. Chang (Aerospace Corp., El Segundo, Calif.) and P. Ramanaiah. *Phys. Fluids*, 4: 1179-81 (Sept. 1961).

A new phenomenological formulation of a unified rheological relation of non-Newtonian fluids is described. This relation checks very closely for many non-Newtonian fluids. As a first approximation, a power law of velocity gradient representing viscosity is also derived for the intermediate range between the upper and lower limits of viscosity. (auth)

30153 STRONG BLAST WAVES IN SPHERICAL, CYLINDRICAL, AND PLANE SHOCKS. Donald L. Jones (National Bureau of Standards, Boulder, Colo.). *Phys. Fluids*, 4: 1183-4 (Sept. 1961).

A calculation was made of the energy parameter B in Taylor's expression for time and position of a shock front: $t = \frac{2}{5}(E/B\rho_0)^{-1/2} R^{3/2}$. For $\gamma = \frac{5}{3}$, values of 5.33, 3.25, and 1.22 were obtained for the spherical, cylindrical, and plane cases, respectively; for $\gamma = \frac{7}{3}$, the values were 3.08, 1.75, and 0.678. (T.R.H.)

30154 HIGH-FREQUENCY TAIL OF CYCLOTRON RADIATION FROM A HOT PLASMA. J. D. Jukes (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *REPLY TO COMMENTS OF J. D. JUKES.* Jay L. Hirshfield (F.O.M. Instituut voor Plasma-Fysica, Rijnhuizen, Jutphaas, Netherlands) and Sandborn C. Brown. *Phys. Fluids*, 4: 1184-5 (Sept. 1961).

It is noted that the entire high-frequency tail of cyclotron radiation does not escape freely in the presence of reflectors in the calculation of the emission spectrum of cyclotron radiation from hot plasma. The reflectors shorten the tail. A mathematical treatment is presented. In the reply, the statement that reflectors are ineffectual for $\omega > \omega_p^*$ is modified to read $\omega > 2\omega_p^*$. (L.N.N.)

30155 COMMENTS ON "RADIATION BY PLASMA OSCILLATIONS." D. A. Tidman (Univ. of Maryland, College Park). *Phys. Fluids*, 4: 1186 (Sept. 1961).

A correction of an algebraic error in a discussion on radio emission by plasma oscillations colliding with a small inhomogeneity in a plasma (*NSA*: 15: 21659) is made. The original general conclusion on the problem is not altered. (L.N.N.)

30156 SCREW INSTABILITY OF A PLASMA COLUMN. F. C. Hoh and B. Lehnert (Royal Inst. of Tech., Stockholm). *Phys. Rev. Letters*, 7: 75-6 (Aug. 1, 1961).

A physical interpretation of the theory of the screw instability in plasma is presented. It is shown that if a screw configuration exists in the plasma, the axial electric field tends to shift the electron component with respect to the positive ion component. The resultant charge separation causes a radial electric field to form, which drives the particles outward and destabilizes the plasma. Conditions under which the screw configuration is stable are discussed. (T.F.H.)

30157 EXPERIMENTAL EVIDENCE FOR BEAM-PLASMA INTERACTION IN A LOW-PRESSURE ARGON DISCHARGE. Lawrence H. Putnam, Harry D. Collins, and Norman L. Oleson (U. S. Postgraduate School,

Monterey, Calif.). *Phys. Rev. Letters*, 7: 77-9 (Aug. 1, 1961).

Experimental evidence is presented that an unmodulated electron beam moving through a homogeneous plasma is unstable. A 40-mm long Ar discharge is observed by probe methods, and the densities and oscillatory properties of the plasma electrons are found. It is suggested that the beam of electrons (which comes from the cathode) becomes unstable, and excites growing longitudinal plasma oscillations, as a result of a decreasing plasma density gradient. (T.F.H.)

30158 PLASMA PRODUCTION BY TRAVELING RESONANT PERTURBATIONS. William I. Linor (Hughes Research Labs., Malibu, Calif.). *Phys. Rev. Letters*, 7: 115-17 (Aug. 15, 1961).

Plasma was produced by traveling resonant perturbations in an axially symmetric field. Particle losses along paths that were mirror images of those producing trapping initially were avoided by providing a nonreciprocal effect. This was accomplished by the use of traveling perturbations, which were achieved by spatial current distribution and polyphase excitation. Apparatus is described. (L.N.N.)

30159 THE FORM OF A MAGNETOHYDRODYNAMIC SHOCK WAVE IN A GAS WITH ANISOTROPIC CONDUCTIVITY. G. A. Lyubimov. *Priklad. Mat. i Mekhan.*, 25: 179-86 (Mar.-Apr. 1961). (In Russian)

An ionized gas, characterized by an anisotropic conductivity, is located in a magnetic field and is sufficiently rarefied so that the electrons can execute spiral trajectories. The equation describing the system is given as $\sigma(E + (1/c)v \times H + (1/me)\text{grad}p_e) = j + (\omega\tau/H)j \times H$ where: σ = average conductivity in the absence of the magnetic field, p_e = electron pressure, n = electrons per unit volume, e = charge on the electron. For the case $\omega\tau \geq 1$ ($\omega = (eH/m_e c)$ the Larmor frequency) the characteristic velocities and linear dimensions of the system admit hydrodynamical treatment. As such, the shock waves generate a narrow current-dependent zone which together with the anisotropic conductivity produces a dissipation function. A system of equations is developed in which it is shown that the points of intersection of integral curves are singular points. It is these singular points which determine the character of the problem, being contained in a discriminant of the characteristic equation. It is shown that the width of the magnetohydrodynamic shock waves in a gas with an anisotropic conductivity is greater than that for the usual magnetohydrodynamic shock wave. Additionally, because of the larger electron orbits ($\omega\tau \gg 1$) the width of the shock waves in a gas with anisotropic conductivity becomes an order of magnitude larger than the Larmor radius of the ions. (TTT)

30160 REFLECTIONS RESULTING FROM WEAK SHOCK WAVES IN GASES OF VARIABLE DENSITY. F. L. Chernous'ko. *Priklad. Mat. i Mekhan.*, 25: 209-17 (Mar.-Apr. 1961). (In Russian)

Previously, plane, cylindrical, and spherical shock waves in gases of variable density have been studied. The elementary states of an ideal gas were given by (1) $\rho = \omega r^s$, $v = 0$, $P = P_0$ where: r = distance of the atoms from the center of symmetry, P = gas pressure, ρ = density v = mass velocity, and P_0 , s , and ω are constants. For a gas diffusing outwardly under condition (1), shock waves can radiate at a point on the axis of symmetry or at the plane $r = 0$. It is shown that the dependence on the numbers s and ν ($\nu = 1, 2, 3$ corresponding to plane, cylindrical, or spherical waves) places an essentially different behavior

on the radiation of the waves at $r \rightarrow 0$. For $s < 2(\nu - 1)$, unbounded shock waves reinforce themselves and maintain their intensity as $r \rightarrow 0$. In this case, one can dimensionally analyze the radiated shock waves. Such an analysis shows that through reflections from the axis, the waves of constant intensity in the gas behind the reflection wavefront are unperturbed. For $s > 2(\nu - 1)$ such a dimensional analysis does not exist. For handling this case, the dynamic gas equations are linearized by superposing weakly radiating shock waves onto the unperturbed motion. This linearization has been validated for $r \rightarrow 0$, $t \rightarrow 0$. In particular, the intensity of the radiated waves rapidly decays toward zero as $r \rightarrow 0$. (TTT)

30161 ON MAGNETOHYDRODYNAMIC FLOW SPACES. M. N. Kogan. *Priklad. Mat. i Mekhan.*, 25: 375-6 (Mar.-Apr. 1961). (In Russian)

It is shown that there are two hyperbolic regions of flow for an ideal gas in the presence of a magnetic field parallel to the velocity of the gas stream. In the supersonic hyperbolic region, the flow is comparable to the usual gasdynamic supersonic flow. In the subsonic hyperbolic region, shock waves are emitted from the upper surface of the stream as evidenced by flow maps. Within the limits of linear theory, it is shown that not only are shock waves emitted but also vortical sheets. These are related to the usual aerodynamic equations describing such flow. Extensions are derived covering cases of quasi-hyperbolic regions. (TTT)

30162 ON SHOCK WAVES IN POLYPHASE GASES EXHIBITING RECTILINEAR CHARACTERISTICS. A. F. Sidorov. *Priklad. Mat. i Mekhan.*, 25: 377-81 (Mar.-Apr. 1961). (In Russian)

The unstable motion of polyphase gases is investigated via the equation $P = a^2(S)\rho$ where P = gas pressure, ρ = gas density and S = entropy, and γ marks its adiabaticity. The deviation of the flow from planar flow is determined for $\gamma \approx 2$. A method is given for determining the shock waves of a given intensity by calculating the motion of the wave fronts considered as sufficiently smooth surfaces which curve in some sense so that the flow behind the wave fronts can be treated as having rectilinear characteristics. Results are transformed from the adiabatic to isothermal cases based on Huygens' principle. Additional developments are to be reported later. (TTT)

30163 HIGH CURRENT GAS DISCHARGES. A. A. Ware (General Atomic Div., General Dynamics Corp., San Diego, Calif.). *Repts. Progr. in Phys.*, 24: 24-68 (1961). (GA-1507)

High-current discharges are taken to be those discharges whose self-magnetic fields play an important role in their behavior. Such discharges were studied mainly in connection with the quest for controlled thermonuclear reactions. Of the many possible configurations for the discharge tube and the electromagnetic fields, the pinch discharges in straight or toroidal tubes have received the most attention and, accordingly, a major part of this review is devoted to these discharges. Other configurations are reviewed. Following an historical and introductory review of the subject, a set of appropriate plasma equations is presented and the common approximations and physical concepts associated with the theory are discussed. The properties of the pinch discharge are considered under the headings Discharge Initiation and Contraction, Equilibrium, Magnetohydrodynamic Stability, Particle Heating and Energy Loss, and Nuclear Reactions. (auth)

30164 THE DYNAMICS OF HIGH TEMPERATURE PLASMAS. W. B. Thompson (Atomic Energy Research

Establishment, Harwell, Berks, Eng.). *Repts. Progr. in Phys.*, 24: 363-424 (1961).

A survey is given of present models of the dynamic behavior of a fully ionized plasma, with particular emphasis on those useful in stability studies. The models discussed include magnetohydrodynamics which, while not fully justified, is widely used, the classical kinetic theory which probably is not applicable to hot laboratory plasmas, and the collisionless kinetic theory, which while incomplete seems suited to the discussion of the stability of plasmas. The properties of small oscillations are discussed, both sound waves and electrical oscillations, and stress is laid on the dielectric behavior of the plasma. A consistent derivation of the Fokker-Planck equation is sketched, using the dielectric properties of the plasma. Many important dynamical problems are omitted—there is no discussion of the collisionless shock, or of the breakdown of hydrodynamic behavior through electron runaway in electric fields, and there is little discussion of particular configurations. (auth)

30165 TRANSMISSION OF A CHARGED PARTICLE THROUGH AN ELECTRON-ION BEAM. N. L. Tsintsadze. *Trudy Inst. Fiz. Akad. Nauk Gruzin. S.S.R.*, 7: 127-33 (1960). (In Russian)

Transmission of a charged particle through an electron-ion beam along its axis is considered. The energy losses are determined. (auth)

30166 DETERMINATION OF THE SHAPE OF AN ELECTRON-ION BEAM IN MAGNETOHYDRODYNAMICAL APPROXIMATION. N. L. Tsintsadze and D. G. Lominadze. *Trudy Inst. Fiz. Akad. Nauk Gruzin. S.S.R.*, 7: 187-92 (1960). (In Georgian)

The shape is determined for a thin axial symmetrical electron-ion beam, the cross section of which changes along its axis. The task is solved in magnetohydrodynamic approximation and the shape of the beam is found for small vibrations. The qualitative consideration is carried out at an arbitrary vibration in respect to the average radius. (auth)

30167 ON THE CONSTANCY OF THE TANGENTIAL BURST IN A RAREFIED PLASMA. L. D. Pichakhchi (Gor'kii Khar'kov State Univ., [USSR]). *Ukrain. Fiz. Zhur.*, 6: 86-92 (Jan.-Feb. 1961). (In Ukrainian)

On the basis of the magnetohydrodynamic equations of Chew, Goldberger, and Low the question of the stability of a tangential burst in a plasma is considered. (auth)

30168 HIGH-FREQUENCY OSCILLATIONS IN LOW PRESSURE DISCHARGE. I. A. Savchenko and A. A. Zaitsev. *Vestnik Moskov. Univ., Ser. III*, 16: No. 2, 19-25 (Mar.-Apr. 1961). (In Russian)

Electron oscillations in plasma are studied, and the influence of the plasma boundary on the excitation and distribution of the oscillations is analyzed. (R.V.J.)

30169 INVESTIGATIONS OF DISCHARGE DEVELOPMENT AND PLASMA PARAMETERS IN LOW-PRESSURE TUBES. T. A. Sanina, A. A. Zaitsev, and A. A. Sanin. *Vestnik Moskov. Univ., Ser. III*, 16: No. 2, 54-9 (Mar.-Apr. 1961). (In Russian)

The mechanism of gas discharge development is studied by the optical method. Experiments indicate a maximum emission intensity in the transition process related to large electron mean energies. The maximum emission intensity is delayed in relation to the current. The total emission in the transition process is two-fold higher than in steady-state operation. (R.V.J.)

30170 REFLECTION OF ELECTROMAGNETIC WAVES FROM PLASMA MOVING IN SLOW WAVE WAVEGUIDE. V. I. Kurilko (Khar'kov Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). *Zhur. Tekh. Fiz.*, 31: 899-906 (Aug. 1961). (In Russian)

Doppler effect is investigated in electromagnetic wave reflection in plasma wave guides. Maximum frequencies were found for the reflected waves, and an expression was developed for the maximum frequency multiplication coefficient. It is shown that under certain conditions the incident wave is completely reflected. (tr-auth)

30171 THE INFLUENCE OF FINITE CONDUCTIVITY ON THE STABILIZATION OF A SLIGHTLY CURVED PLASMA COLUMN. [PART] I. Yu. V. Vandakurov (Leningrad Inst. of Physics and Tech.). *Zhur. Tekh. Fiz.*, 31: 907-15 (Aug. 1961). (In Russian)

The state of a slowly-diffusing radial pinch plasma in a constant electric field and a strong magnetic field is investigated. An expansion is found for resolving the equilibrium equation by considering a finite conductivity in accord with pinch curvature parameters. At zero approximation the pinch axis is rectilinear and diffusion is determined by an ordinary classical formula. The solution considering curvature was further developed and indicated the presence of strong transverse mass flow, causing an abnormally high loss of charged particles. The calculated losses coincide with experimental measurements. The solution shows that a plasma pinch must rotate in relation to its axis, otherwise the velocity distribution conditions are too rigid. (tr-auth)

30172 IMPROVEMENTS IN OR RELATING TO GAS DISCHARGE APPARATUS. Robert Carruthers and David Lorimer Smart (to United Kingdom Atomic Energy Authority). British Patent 876,891. Sept. 6, 1961.

A gas discharge apparatus is described that consists of means for inducing a pinched ring discharge in gas in a toroidal vessel. The means is adapted to produce a relatively fast initial rise of discharge current followed by a relatively slow further rise to the final value. The means may consist of a low-energy bank of fast capacitors which are discharged through a low-inductance primary winding of the transformer to initiate the discharge, and a cheaper form of energy store, such as a slow capacitor bank or an inductor, for supplying the remaining energy relatively slowly thereafter to a separate high-inductance primary winding. (N.W.R.)

Shielding

30173 (BNL-684) HEAT TRANSFER STUDY OF COBALT-60 SHIPPING CONTAINER. Progress Report No. 2. L. B. Adler (Brookhaven National Lab., Upton, N. Y.). June 1961. 14p.

Further heat transfer studies were made of a 7-ton cobalt-60 shipping container with approximate 81,000-curie cobalt loading. The container used was of revised geometry to that employed in initial experiments due to the inclusion of an added shielding liner. Measured surface temperatures indicated that the revised container is safe; maximum temperatures run slightly higher than obtained previously. Temperature data show that air-flow conditions within the source lattice are relatively stagnant and that convective heat removal is small. Non-radial heat flow paths appear to be minimal. A direction for future experiments is indicated; revisions to present apparatus are described. (auth)

30174 (UCRL-9769) EVALUATION OF SHIELDING REQUIRED FOR THE IMPROVED BEVATRON. Burton J. Moyer (California. Univ., Berkeley. Lawrence Radiation Lab.). June 27, 1961. Contract W-7405-eng-48. 14p.

The thickness of shielding wall and roof needed at the Bevatron in order to assure safe radiation levels in the surroundings was calculated on the assumption of a beam of 10^{13} protons per pulse at 10 pulses per minute expected as a result of improvements. (auth)

30175 (WAPD-T-1231) SOLUTION OF THE TRANSPORT EQUATION BY THE METHOD OF POLYNOMIAL EXPANSION. PART I. B. D. O'Reilly (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). July 1961. Contract AT-11-1-GEN-14. 13p.

Presented at the Winter Meeting of the American Nuclear Society in San Francisco, California, December 1960.

The transport equation is considered in an infinite slab having a finite thickness, for the case in which the boundary conditions are nonvanishing on the slab faces. The density function at the slab faces is expressed as a Legendre polynomial expansion, in which the expansion coefficients are regarded as the unknowns. Thus the boundary conditions are given in terms of linear combinations of the unknowns. The convergence of these expansions is discussed. Both half-range and full-range Legendre polynomials are considered. (T.F.H.)

30176 (WAPD-T-1232) SOLUTION OF THE TRANSPORT EQUATION BY THE METHOD OF POLYNOMIAL EXPANSIONS. [PART] II. D. C. Anderson (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 29, 1960. Contract AT-11-1-GEN-14. 19p.

Presented at the Winter Meeting of the American Nuclear Society in San Francisco, California, December 1960.

A Legendre polynomial expansion method may be used to find the transport equation in a thin infinite plane slab. Detailed applications of this method are shown. The method's validity is examined by comparing its results with exact calculations and computer codes, and by comparison of successive orders of approximation within the polynomial method. The method is generalized to the multiple-slab and energy-dependent cases. The transport of γ radiation through Pb is studied as an example. (T.F.H.)

30177 THE γ -RAY ATTENUATION OF Co^{60} , Cs^{137} , AND Au^{198} BY A CYLINDRICAL LEAD SHIELD. Z. S. Arefeva, V. V. Bochkarev, L. M. Mikhailov, and L. V. Timofeev. *Atomnaya Energ.*, 11: 186-7 (Aug. 1961). (In Russian)

One- to ten-curie sources of Co^{60} , Cs^{137} , and Au^{198} were placed within the inner cylinder of a series of six concentric lead cylinders. Readings were taken at distances of 17.5 and 25 cm from the source. The γ -sources can be considered as point sources at these distances. Comparative readings were also taken on the same source with plane lead sheets $500 \times 500 \times 5$ mm. It was found that the attenuation factors obtained with the cylindrical shielding were greater than the attenuation factors obtained with the plane shielding. The ratio of the attenuation with cylindrical shielding to the attenuation with plane shielding ($\eta = K_{\text{cyl}}/K_{\text{plan}}$) depends on the γ -ray energy and on the shielding thickness. The values of η are 2.2, 1.7, and 1.3 for γ -rays with energies of 0.411 Mev (Au^{198}), 0.667 Mev (Cs^{137}) and 1.25 Mev (Co^{60}) respectively. (TTT)

30178 GENERAL-PURPOSE TABLES FOR CALCULATING THE γ -RAY SHIELDING OF TUNGSTEN AND URANIUM. L. M. Mikhailov and Z. S. Aref'eva. *Atomnaya Energ.*, 11: 187-9 (Aug. 1961). (In Russian)

Materials with a high atomic number and a high density such as uranium (atomic number $Z = 92$; density $\rho = 18.7 \text{ g/cm}^3$) and tungsten ($Z = 74$ and $\rho = 19.3 \text{ g/cm}^3$) are being used more widely in the design of compact, protective gamma shields. General-purpose tables were computed for uranium and tungsten on the basis of theoretical build-up factors for an infinite plane source. The shield thickness is given in centimeters for γ -ray attenuations of 1.5 to 10^7 at γ -ray energies of 0.1 to 10 Mev . The values in the tables are 5 to 10% too large, and hence, can be considered as conservative values. (TTT)

30179 FLEXIBLE NEUTRON SHIELD. Jean Duchêne (to Commissariat à l'Energie Atomique). Canadian Patent 625,555. Aug. 15, 1961.

A flexible neutron shield may be made using a material which consists of powdered boron carbide incorporated in a flexible polyvinyl chloride binder. (D.L.C.)

Theoretical Physics

30180 (ML-805) STATISTICAL MECHANICAL BASIS FOR THE SECOND LAW OF THERMODYNAMICS. R. A. Nelson (Stanford Univ., Calif. Microwave Lab.). Apr. 1961. Contract AF49(638)-342. 65p. (AFOSR-630)

Any system as a whole is assumed to be described by some definite, though unknown, pure global state whose time development is given by the Schrödinger equation. However, it is impossible to determine the exact global state because only macroscopic control (and knowledge) of experimental conditions is possible. This state of knowledge can be represented by a density matrix. The most uniform assignment of weights to the possible global states is given by the density matrix, ρ , which maximizes the Shannon expression for entropy, $S_1 = -\text{Tr}(\rho \log \rho)$, subject to the constraints imposed by the macroscopic conditions. The concept of a sharply defined high-probability manifold is introduced by considering the linear vector space spanned by all possible global wave functions of a system of N elementary parts. Let the eigenvalues, ρ_i , of the density matrix be labeled such that $\rho_1 \geq \rho_2 \geq \rho_3 \geq \dots$ and define $W(N,\epsilon)$ as the smallest positive integer such that

$$\sum_{i=1}^{W(N,\epsilon)} \rho_i > 1 - \epsilon, \text{ where } 0 < \epsilon < 1. \text{ The manifold } M$$

spanned by the first $W(N,\epsilon)$ global states is called the high-probability manifold. It is said to be sharply defined if $\lim_{N \rightarrow \infty} (1/N) \log W(N,\epsilon)$ is independent of ϵ . The experimental entropy, S_e , is then identified with $k \log W$ where k is the Boltzmann constant. At an initial time, $t = 0$, there is a high-probability manifold $M(0)$ of dimensionality W determined by the macroscopic parameters, giving an initial experimental entropy, $S_e(0) = k \log W$. As time progresses a new linear manifold $M(t)$ evolves, by means of a unitary transformation so the dimensionality W remains constant. But at a new time the values of the macroscopic parameters may have changed and they determine a new high-probability manifold $M'(t)$ in the same way that $M(0)$ was determined. If the change is an experimentally reproducible one, essentially all of the global states in $M(0)$ must give the same new values for the macroscopic parameters and, therefore, lead at time t , to states lying within $M'(t)$. Thus the dimensionality W' of $M'(t)$ cannot be less than W and the new entropy $k \log W'$ cannot be less than $k \log W$. Thus it is shown that the existence of a sharply defined high-probability manifold plus the unitarity of transformations generated by the Schrödinger equation are sufficient to demonstrate the second law of thermodynamics. (auth)

30181 UNIFIED FIELD TRAJECTORIES. Jack Levy (Institut Henri Poincaré, Paris). Acta Phys. Acad. Sci. Hung., 13: 1-9(1961). (In French)

From a unified Lagrangian, a system with four identities, which by the intermediary of field equations lead rigorously to trajectory equations, is deduced. A charge/mass ratio can then be identified. (tr-auth)

30182 CHANGE OF VARIABLES IN QUANTUM FIELD THEORIES. J. S. R. Chisholm (University Coll., Cardiff, Wales). Nuclear Phys., 26: 469-79(1961). (In English)

It is shown that any local or almost local change of variables in quantum field theories, which leaves the free field part of the Lagrangian unchanged, does not alter the S -matrix. The relation of this result to Haag's theorem is discussed. (auth)

30183 DIMENSIONLESS QUANTITIES, SPACELIKE INTERVALS AND PROPER TIME IN GENERAL RELATIVITY. A. Finzi (Università, Rome and Israel Inst. of Tech., Haifa). Nuovo cimento (10), 20: 1079-89(June 16, 1961). (In English)

It is shown that metric measurements, which are essential to the theory of general relativity, are those based only on strong and electromagnetic interactions. Strong and electromagnetic interactions must not vary throughout the four-dimensional world, if general relativity is to remain a meaningful theory. The implications of these remarks on cosmology are discussed. (auth)

30184 A COVARIANT FORMULATION OF QUANTUM MECHANICS. [PART] I. G. Szamosi (Israel Atomic Energy Commission, Rehovoth). Nuovo cimento (10), 20: 1090-1101(June 16, 1961). (In English)

An attempt is made to introduce explicitly the concept of an invariant time parameter (proper-time) into the relativistic one-particle quantum mechanics. A compact unified formulation of the free scalar and spin $1/2$ particles is presented. Covariant equations of motion, including the covariant Zitterbewegungen, are derived. The quantum equations of motion are compared to the classical ones and their relationship is discussed briefly. (auth)

30185 A NOTE ON CIRCULAR GRAVITATIONAL ORBITS. P. Goldhammer (Univ. of Nebraska, Lincoln). Nuovo cimento (10), 20: 1205-6(June 16, 1961). (In English)

The Schwarzschild circular orbits provided by the general theory of relativity for a mass circulating about a fixed mass are examined. For a given angular momentum, two circular orbits are described. It is found that there are also two circular orbits for a photon; certain energies cause these orbits to be unstable under relativistic considerations. (L.N.N.)

30186 DIFFERENTIAL AND TRANSPORT CROSS SECTIONS FOR CLASSICAL SCATTERING BY REPULSIVE POTENTIALS. E. M. Baroody (Battelle Memorial Inst., Columbus, Ohio). Phys. Fluids, 4: 1182-3(Sept. 1961).

An idea of Bohr's is developed in which an exponentially screened Coulomb potential is compared with an inverse power law potential, the constants being chosen so that value and slope are correct in the region of most importance for the collisions of interest. (L.N.N.)

30187 LIFETIME EFFECTS IN CONDENSED FERMION SYSTEMS. A. Bardasis and J. R. Schrieffer (Univ. of Illinois, Urbana). Phys. Rev. Letters, 7: 79-81(Aug. 1, 1961).

The superconducting energy gap is found at 0°K as a function of the momentum-energy four-vector. A damping factor is found that is proportional to some power n of the

momentum. The damping is found for $n = 0, 1$, and 2 . For $n = 2$ (quadratic damping), which corresponds to the situation observed in superconductors and He^3 , the superconducting and superfluid critical temperature is calculated to be about $8 \times 10^{-4}\text{K}$. (T.F.H.)

30188 PERSISTENT RING CURRENTS IN AN IDEAL BOSE GAS. J. M. Blatt (Bell Telephone Labs., Murray Hill, N. J. and Univ. of New South Wales, Kensington, Australia). *Phys. Rev. Letters*, 7: 82-3(Aug. 1, 1961).

The electrical resistivity of a system of non-interacting Bose-Einstein particles is studied theoretically below the Bose-Einstein condensation point. An electrically conducting ring is placed in a magnetic field and cooled below the condensation point. It is shown that, when the magnetic field is removed, a current is initiated in the ring that maintains the external magnetic flux at its original value. The model used does not require the existence of an energy gap, and the flux is not quantized. The Bose particles may or may not be regarded as electron pairs. (T.F.H.)

30189 LINEAR EFFECT OF APPLIED ELECTRIC FIELD ON MAGNETIC HYPERFINE INTERACTION. N. Bloembergen (Harvard Univ., Cambridge, Mass.). *Phys. Rev. Letters*, 7: 90-2(Aug. 1, 1961).

It is shown that magnetic hyperfine interactions, either isotropic or anisotropic, may be linear functions of the applied electric field, E . It is assumed that the nucleus in question is not located at a center of inversion symmetry. The hyperfine interaction of F^{19} in MnF_2 is considered as an example. The change in the F^{19} resonant frequency, caused by a field $E = 10^4$ v/cm along the $[110]$ direction, is calculated to be 108 kc at 4.2°K . (T.F.H.)

30190 IMAGE OF THE FERMI SURFACE IN THE LATTICE VIBRATIONS OF LEAD. B. N. Brockhouse, K. R. Rao, and A. D. B. Woods (Atomic Energy of Canada Ltd., Chalk River, Ont.). *Phys. Rev. Letters*, 7: 93-5 (Aug. 1, 1961).

Neutron scattering by Pb is studied using a triple-axis crystal spectrometer oriented such that for each energy distribution, the momentum transfer $\hbar\vec{Q}$ remains fixed. The Pb is fcc with a lattice constant a . The scattered neutrons determine the frequencies ν of the lattice vibrations of \vec{Q} . When ν is shown as a function of $a\vec{Q}/2\pi$, from $(1, 1, 1)$ to $(2, 2, 2)$, sharp discontinuities are observed near and on either side of $(1.5, 1.5, 1.5)$ that have infinite slope. These discontinuities in the dispersion curves are examined in terms of Fermi surfaces in reciprocal lattice space. (T.F.H.)

30191 THEORY AND APPLICATIONS OF THE DENSITY MATRIX. D. Ter Haar (Clarendon Lab., Oxford). *Repts. Progr. in Phys.*, 24: 304-62(1961).

After a qualitative discussion of the advantages of the density matrix and of the different ways to introduce it (the statistical, quantum mechanical, and operational methods of approach), the general properties of the density matrix is discussed including a discussion of pure cases and mixtures. A brief discussion is given of Green function techniques and of the relation between Green functions and correlation functions. A discussion of recent developments in the evaluation of partition functions concludes the first part dealing with the theory of density matrix techniques. The first application treated is the quantum-chemical one to many-body systems in their ground state, that is, systems at absolute zero, and it is shown how the density matrix fits into the Hartree-Fock and Thomas-Fermi schemes. A brief discussion is given of the theory of diamagnetism. This is followed by a discussion of non-equilibrium processes and of Kubo's approach to transport theory. After that the polarization of beams of electrons or of photons is discussed and it is indicated how density matrix techniques can be used to treat scattering processes. A brief account is given of density matrix theory applications to resonance and relaxation phenomena. Finally, the theory of measurement in quantum mechanics is considered. (auth)

REACTOR TECHNOLOGY

General and Miscellaneous

30192 (AERE-M-894) SOME MEASUREMENTS OF THE NEUTRON FLUX IN THE SPENT FUEL ELEMENT IRRADIATION POND AT HARWELL. R. W. Clarke, J. B. Price, and C. A. Lowe (United Kingdom Atomic Energy Authority, Research Group, Atomic Energy Research Establishment, Harwell, Berks, England). June 1961. 24p.

Indium foil activation showed the neutron fluxes in the assembly to be very small and to be the result of the (γ, n) reaction on deuterium by 2.5-Mev gammas emitted by La^{140} . Correlation of neutron and gamma field showed that the strongest fields obtainable will not induce significant activity in irradiated samples. (auth)

30193 (ANL-6337) CRITICAL STUDIES OF A DILUTE OXIDE FAST REACTOR CORE (ZPR-III ASSEMBLY 30). P. I. Amundson, A. L. Hess, W. P. Keeney, J. K. Long, and R. L. McVean (Argonne National Lab., Idaho Falls, Idaho). May 1961. Contract W-31-109-eng-38. 23p.

Critical studies of a fast reactor core containing a simulated oxide fuel having an oxygen-uranium atomic ratio of 1:1 are described. Calculated and experimental critical masses are compared. Experimental results are given for fission ratio, central reactivity coefficient, fuel bunching, and distributed worth measurements. (auth)

30194 (ANL-6377) PROCESS VESSEL DESIGN FOR FROZEN-WALL CONTAINMENT OF FUSED SALT. R. W. Kessie, J. D. Gabor, W. J. Mecham, and A. A. Jonke (Argonne National Lab., Ill.). Aug. 1961. Contract W-31-109-eng-38. 25p.

The feasibility of the containment of a molten sodium fluoride-zirconium fluoride salt at 550°C in vessels with a protective inner liner of frozen salt of the same composition was demonstrated. Two different designs were used for supplying internal heat directly to the molten salt: induction heating and electrolytic heating. The test equipment was of a size practical for processing zirconium-uranium alloy reactor fuel by the Fused Salt Process. (auth)

30195 (ANL-6382) A DESCRIPTION OF INTEGRAL PHYSICS DATA FOR FAST REACTOR DESIGN. W. B. Loewenstein and D. Meneghetti (Argonne National Lab., Ill.). July 1961. Contract W-31-109-eng-38. 29p.

Integral physics data for fast reactor design are discussed. The measurements needed include those of critical mass, shape factor, detector ratios, neutron spectra, material replacement experiments, reflector savings, neutron lifetime, Rossi- α , and similar quantities. Topics covered include Pu- and U^{233} -fueled systems, highly enriched U^{235} systems in optimum geometry, uranium cores of various enrichments and dilutions, extreme geometry critical experiments, specific reactor systems, core mockup inhomogeneities, spectral studies and detector ratios, uranium equilibrium spectrum data, material-replacement measurements, fast reactor dynamics, and suggested future experiments and experimental programs. (M.C.G.)

30196 (ANL-6399) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT [FOR] JULY 1961. (Argonne

National Lab., Ill.). Aug. 15, 1961. Contract W-31-109-eng-38. 75p.

A summary is presented of activities in reactor and general engineering research programs. Discussions are included for developments in EBWR, BORAX-V, ZPR-III, ZPR-VI, ZPR-IX, EBR-I, and EBR-II. Reactor safety studies were performed for fast and thermal reactors. Nuclear technology developments are discussed for applied nuclear and reactor physics, reactor fuels and materials development, heat engineering studies, separations processes, and advanced reactor concepts. (B.O.G.)

30197 (APAE-Memo-289) BOBCAT (PROGRAM NO. 56) CODE PREPARATION ANALYSIS ON THE IBM-650. P. E. Bobe and R. L. Caton (Alco Products, Inc., Schenectady, N. Y.). Aug. 9, 1961. Contract AT(30-1)-2639. 98p.

The BOBCAT code that is programmed for the IBM-650 is described. The code facilitates the nuclear analysis of APPR-type cores by performing many of the routine calculations necessary to obtain input to various IBM-650 and IBM-704 codes. Using fuel element geometry and U^{235} and B^{10} loadings as input, the code prepares input to the MUFT-III and various P_3 codes as output; in addition, a large amount of detailed descriptive core data that is useful in nuclear analysis calculations is generated. (auth)

30198 (CF-61-8-58) PRELIMINARY ANALYSIS OF THE HFIR CONTROL RODS. T. G. Chapman (Oak Ridge National Lab., Tenn.). Aug. 18, 1961. 24p.

An analysis is made of the HFIR control concept in order to evolve a mechanical design for the control rods. Since the original design considered does not meet the objectives, the design is altered to include 1% holes in the white region and 2 to 4% holes in the grey region. (auth)

30199 (CVNA-92) EVALUATION OF ZIRCALOY-2 UNIFORM WALL AND FINNED TUBING FOR CVTR FUEL ELEMENT FABRICATION. SUBTASK 6.01: FUEL ELEMENT CLADDING AND METAL JOINING OF FUEL ASSEMBLIES. Terminal Report. E. S. Foster and P. P. King (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). July 26, 1961. For Carolinas Virginia Nuclear Power Associates, Inc., Charlotte, N. C. Contract AT(30-1)-2289. 51p.

Zircaloy tubing engineering results showed that uniform wall Zircaloy tubing should be procured for CVTR Core I rather than integral finned tubing. The recommendation was based on the fact that fabrication techniques were not developed for production of quality integral finned tubing in time for CVTR fuel element fabrication. Zircaloy-4 tubing containing approximately 15% cold work was recommended for CVTR fuel cladding. Data were obtained to establish Zircaloy tubing requirements to be used in specifying fuel cladding for the CVTR core. (auth)

30200 (GA-1854) DEVELOPMENT OF METAL-CLAD FUEL ELEMENTS FOR THE HIGH-TEMPERATURE GAS-COOLED REACTOR. W. P. Wallace, D. W. Ver Planck, T. A. Trozera, B. Turovlin, and R. A. Skeehean (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Mar. 17, 1961. Contract AT(04-3)-314. 72p.

Preliminary development of a metal-clad element for the High Temperature Gas Cooled Reactor (HTGR) is summarized. Such operations as cladding of graphite tubes with stainless steel and Monel, welding of end caps, and thermal-cycling tests of prototype elements are discussed, and

the design, engineering, and construction of autoclaves for the assembly of test specimens and for the thermal-cycling tests are described. The results of the experimental work showed that cladding of full-diameter, full-length graphite tubes with thin metal sheaths (0.010 in. or 0.015 in. thick) was feasible. Thermal-cycling tests demonstrated successful operation of a metal-clad element, i. e., no wrinkling or fracture of the cladding, for 76 cycles to a maximum temperature of 1500°F. It was concluded that the development of a metal-clad element for HTGR was technically feasible. However, the parallel program to develop graphite-clad fuel elements had progressed so that the development of metal-clad fuel elements was terminated in July, 1960. (auth)

30201 (GAMD-788) A THERMAL MOCK-UP OF AN IRRADIATION CAPSULE. L. D. Palmer (General Atomic Div. General Dynamics Corp., San Diego, Calif.). May 12, 1959. 13p.

A heat transfer test of a modified irradiation capsule was conducted to determine if the temperature of the fuel body can be satisfactorily controlled when the capsule is being irradiated by altering the composition of the gas filling a void between the inner and outer stainless steel containment cans. Seven sets of data were taken, five with helium as the gas between the cans and two with argon. These tests demonstrated that the temperature of the fuel body can be controlled by changing the gas composition in the gap between the cans. (auth)

30202 (GAMD-1157) THE EFFECT OF THE $(n,2n)$ AND THE (n,α) REACTIONS ON THE REACTIVITY OF MGCR BERYLLIUM OXIDE MODERATED CORES. A. J. Goodjohn (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Dec. 28, 1959. Contract AT(04-3)-187. 29p. (MGCR-RP-128).

The effects of the reactions $\text{Be}(n,2n)$, $\text{Be}(n,\alpha)$, and $\text{O}(n,\alpha)$ on the reactivity of the Maritime Gas Cooled Reactor are calculated over the core lifetime. These reactions cause a buildup of Li^6 and He^3 in the reactor. The increase in reactivity from the $(n,2n)$ reaction, as well as the decrease in reactivity from the (n,α) reactions and the neutron absorption by Li^6 and He^3 , are studied. (T.F.H.)

30203 (GEAP-3655) PRESSURE DROP ALONG A FUEL CYCLE FUEL ASSEMBLY VARIOUS ORIFICE CONFIGURATIONS. E. Janssen and J. A. Kervinen (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). May 22, 1961. Contract AT(04-3)-189. 102p.

The relationships between pressure loss and orifice configuration, mass rate, and steam quality were determined for a Fuel Cycle fuel assembly. The Fuel Cycle fuel bundle, 16 rods 0.423 in. diameter and 40 in. long, was installed in a 3×3 channel with a nose piece at the lower end. Measurements of pressure drop along the channel were made with no orifice and with various restricting orifices of two basic types. The pressure loss was resolved into 6 component losses. Single-phase and two-phase loss coefficients were calculated. (M.C.G.)

30204 (GEAP-3709) FUEL CYCLE PROGRAM, A BOILING WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. THIRD QUARTERLY REPORT, JANUARY 1961-MARCH 1961. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Contract AT(04-3)-189, Project Agreement No. 11. 63p.

The continuing analysis of the VBWR core resulted in refinements in the calculations for reactivity in voids, fuel leakage and resonance escape probability. The Zircaloy cladding for 25 fuel assemblies was received and passed

inspection. Preliminary measurements of VBWR flux oscillations, used to develop instrumentation and data interpretation techniques, showed random normally-distributed oscillations with a predominant frequency of 0.5 to 1.0 cycles/second. A model for analog computer simulation of a reactor as a feedback control system was adapted to VBWR. Equations for the hydraulics model and preliminary results from use of the model are presented. Irradiation of the Fuel Cycle stainless steel clad assemblies reached 412 MWD/T with specific powers of 28 kw/kg (average) and 52 kw/kg (peak) during January. Visual examination of the fuel after this irradiation indicated that it is in good condition. The VBWR was shut down during February and March for replacement of all in-core components made of 17-4 pH stainless steel with 304 stainless steel. The details of the first eight special fuel assemblies were determined and materials were ordered. The effects of steam quality, mass flow rate, and rod diameter on burnout heat flux are shown. The burnout heat flux varied inversely with mass flow rate; this result was contradictory to several previous correlations. The experimental phase of the high-pressure observational boiling experiment was completed. Reproducibility of the burnout points was good (about $\pm 1\frac{1}{2}\%$). High speed movies of the flow conditions at burnout are being analyzed. (auth)

30205 (GEAP-3749) PRESSURE DROP OF MULTI-ROD ELEMENTS WITH HELICAL SPRING SPACERS. E. P. Quinn (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). June 1961. Contract AT(04-3)-361. 38p.

The pressure drop of a new fuel element design concept of spacing rods by means of helical wire springs was investigated experimentally and analytically. Extensive single- and two-phase pressure drop data at 1,000 psia were obtained for one flow geometry and helical spring spacer. Test conditions ranged from 0.7 to 1.2×10^6 lb/hr ft² in mass velocity and from 0 to 15% in quality. The effect of the specific spring which was tested was to increase the over-all pressure drop by 70%. A general analytical model was developed to predict the pressure drop of an element with helical spring spacers when the pressure drop without springs is known. The accuracy of the model, compared to the experimental data, was better than $\pm 22\%$. The analytical model allows determination and evaluation of an optimum helical spring spacer design, so that pressure drop will not be a serious disadvantage. (auth)

30206 (IDO-16655) A METHOD OF DETERMINING THE INTERMEDIATE ENERGY NEUTRON DOSE. Dale E. Hankins (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Mar. 10, 1961. Contract AT(10-1)-205. 45p.

The intermediate energy neutron flux existing outside the biological shielding of reactors has not been studied to any great extent previous to this time, because of the lack of an instrument capable of detecting neutrons in the intermediate energy range. The instrument used at the MTR utilizes polyethylene spheres of various sizes to give different amounts of moderation and absorption to the impinging neutrons. A procedure for the approximate determination of the relative number of intermediate energy and fast neutrons is given. By graphical methods the following information is obtained: (1) fraction of intermediate neutrons, (2) fraction of fast neutrons, and (3) the approximate average energy of the fast neutrons. Since the instrument described can be used to determine the thermal neutron flux independent of intermediate and fast fluxes, only one instrument is required to determine the neutron flux

in all three energy ranges. Dose calculations indicate the intermediate range neutrons give a dose greater than the dose delivered by fast neutrons around the MTR-ETR reactors under normal operating conditions. (auth)

30207 (IDO-16691) EXPERIMENTAL AND ANALYTICAL REACTIVITY STUDIES OF CLEAN CRITICAL STAINLESS STEEL CORES. A. H. Spano (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). June 18, 1961. Contract AT(10-1)-205. 29p.

The results are presented of critical water height measurements made on close-packed lattices of Spert III, highly enriched, plate-type, stainless-steel-clad fuel elements. Experiments were conducted with cores containing no control rods and with cores containing a single, fully-inserted control rod. The "clean critical" data obtained in these experiments were used to test the validity of various aspects of a four-group, diffusion theory analysis of the full scale Spert III reactor. The results of the analyses of the rod-free and single-rodged critical lattices show that for such stainless steel cores k_{eff} can be calculated to within 1% Δk and that the Spert III control rod worth is calculable to a few tenths % Δk . (auth)

30208 (IDO-16701) DYNAMIC PROPERTIES OF HETEROGENEOUS WATER REACTORS. S. G. Forbes and W. E. Nyer (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 20, 1961. Contract AT(10-1)-205. 17p.

The types of tests performed in SPERT-I, and the tests proposed for SPERT-II and -III, are described. These reactors are described, and factors influencing their dynamic behavior are discussed. The tests are classed as static, step, ramp, and oscillatory. The correlation between the test results and the reactor dynamic safety characteristics (stability, self-shutdown under excursion conditions, etc.) is investigated. (T.F.H.)

30209 (KAPL-2151) VARIATIONAL METHOD IN THE CALCULATION OF REACTOR NEUTRON FLUX DENSITY. Frank D. Judge (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 21, 1961. Contract W-31-109-Eng-52. 43p.

The variational method, when applied to the one-dimensional, one-velocity Boltzmann equation, leads to simple relations for the spatial average of the scalar flux density or the spatial average of the vector flux density in each region of an arbitrary slab array. It is shown that these relations are correct to the first order. The resultant matrix equations were coded for a high-speed digital computer. Solutions of these equations for specific cases were compared with solutions obtained with high-order P_1 numerical calculations. The variational solution of the Boltzmann equation was then used to check various approximations made in reactor calculations. The substitution of an equivalent isotropic scattering medium for an anisotropic scattering medium was studied. Finally, the error involved by the replacement of an anisotropic source by an isotropic source was investigated. (auth)

30210 (KAPL-M-PAL-1) CLIP—THE CYLINDRICALLY LOADED INTEGRATING PLATFORM. L. D. Cohen and P. Buck (Knolls Atomic Power Lab., Schenectady, N. Y.). June 15, 1961. Contract W-31-109-Eng-52. 45p.

An experimental technique was devised in conjunction with a new type of counting device, which permits the direct measurement of local to reactor core average power density. The unique feature of this system is the manner in which the core average power density is determined. By placing a large number of activated fuel plates on the

circumference of a cylinder, on the axis of which is located a gamma ray detector, the integrated induced gamma ray activity of the group of fuel plates is measured. Since the gamma ray activity is directly proportional to the power developed in the set of fuel plates being counted, the total activity of all of the fuel plates in a reactor may be measured by counting all of the reactor fuel plates in groups, and a number proportional to the core average power density can then be obtained by dividing the total counts for all of the fuel plates by the volume of fuel counted. The cylindrical platform, called the "Cylindrically Loaded Integrating Platform," in conjunction with a tab counter and an axial scanning counter comprise the complete counting system. This system has been used extensively to measure three dimensional power distributions for a variety of critical assembly cores. The results were found to be consistent and reproducible to within 3%. (auth)

30211 (LA-2528) REMOTE INSTRUMENTATION SYSTEM FOR A NUCLEAR PROPULSION TEST REACTOR. William J. Plummer (Los Alamos Scientific Lab., N. Mex.). Feb. 1961. Contract W-7405-eng-36. 75p.

The Rover Program is a continuing project to develop a nuclear reactor for incorporation into a rocket propulsion engine. The instrumentation involved in testing the second device, Kiwi A-Prime, is described. Characteristic features of the system included remote control over two miles of wire telemetry and the restrictions imposed by a radiation environment. Results of efforts to utilize relatively new data handling techniques were encouraging, and these were assimilated into planning for the next series of reactors. (auth)

30212 (NAA-SR-5898) ANALYSIS OF SRE POWER EXCURSION OF JULY 13, 1959. F. L. Fillmore (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 15, 1961. Contract AT(11-1)-GEN-8. 47p.

While the reactor core and coolant were contaminated with tetralin and its decomposition products, the SRE experienced a power excursion. The power level rose from about 4 to 14 Mw, or to 70% of full rated power, before the reactor was scrambled. The shortest period reached was about 7.5 sec. The results were presented of a study whose purpose was to determine the cause of the excursion. A description of reactor operating conditions and a chronology of events preceding the excursion were presented. The extent of fuel channel plugging and the temperature within severely plugged channels were discussed. It was concluded that the most probable cause of the excursion and relatively short reactor period was the evacuation of sodium from several fuel channels, which produced a sudden reactivity increase of about 0.3%. The conditions under which the channels could be evacuated of sodium were directly attributable to the presence of substantial quantities of organic material in about one-fourth of the fuel channels in the reactor. (auth)

30213 (NAA-SR-6409) EXPONENTIAL MEASUREMENTS IN DIPHENYL-MODERATED, URANIUM-METAL LATTICES. R. W. Campbell, T. L. Guzzle, and R. K. Paschall (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 15, 1961. Contract AT(11-1)-GEN-8. 23p.

Material buckling and intracell flux distribution measurements are made for a series of diphenyl-moderated, uranium-metal exponential assemblies. The lattices consist of square cells with a 1-in.-diameter fuel element located at the center and spaced to give moderator-to-fuel (M-F) ratios of approximately 1.5, 2, 3, 3.5, and 4. Fuel

enrichments of 0.4962, 0.7205, and 0.9124 at.% are used. The lattice is maintained at a temperature of 180°F. Measurements are conducted for natural fuel with a 3.15 M-F ratio, and the buckling is found to be $-4.1 \pm 0.5 \text{ m}^{-2}$. Intra-cell flux distributions are measured for eight lattices and compared with calculations using cross-sections averaged over a Wigner-Wilkins spectrum. Agreement is good for small spacings but grows worse as the cell size increases, because the cell structure departs from the homogenized cell used to calculate the neutron spectrum. Thermal utilizations are calculated from both the measured and calculated flux distributions and are found to disagree by less than 2%. (auth)

30214 (NAA-SR-Memo-2490) NUCLEAR CALCULATIONS FOR THE ORGANIC MODERATED CRITICAL FACILITY (OMRCF). J. J. McClure (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 4, 1958. 11p.

A two-group diffusion theory analysis was made of the OMRCF with fuel enrichment of 1.884% and lattice spacings of 6 in. to calculate the nuclear characteristics needed to evaluate the potential hazards of the facility. (B.O.G.)

30215 (NAA-SR-Memo-3116) TEMPERATURE DEPENDENCE OF THE THERMAL NEUTRON FLUX DISTRIBUTION FOR A SQUARE URANIUM GRAPHITE LATTICE. C. H. Skeen (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 19, 1958. 5p.

The temperature coefficients of the ratio of the average thermal neutron flux in the moderator to that in the fuel and of the thermal utilization were measured in a square array of fuel elements in graphite moderator. The linear coefficients were found to be $-3.42 \pm 0.09 \times 10^{-2}/^\circ\text{C}$ for the ratio and $1.5 \pm 0.4 \times 10^{-4}/^\circ\text{C}$ for the utilization over the range 18 to 118°C. (D.L.C.)

30216 (NAA-SR-Memo-6448) PRELIMINARY POPR CONCEPTUAL DESIGN EXCURSION STUDY. F. J. Halfen (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). June 1, 1961. 45p.

An excursion analysis on the conceptual POPR design was performed. This consisted of a study of various accidents using design as well as estimated values for system parameters. The accidents studied and discussed include those involved in startup, rod withdrawal, step reactivity insertion, loss of coolant flow, loss of coolant, and cold inlet. Both protected and unprotected accidents were considered. In the protected accidents studied, the hot spot surface temperature did not exceed 875°F and the burnout margin did not decrease below 1.66. (auth)

30217 (NAA-SR-Memo-6515) SNAP 10A ESTIMATED ELECTRICAL CHARACTERISTICS. J. C. Cooper (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). June 9, 1961. 8p.

The electrical power characteristics of a SNAP 10A converter are estimated for given fractions of power degradation. Graphs are included showing the power characteristics for instantaneous transients from stabilized operation at the maximum efficiency point, and after system temperature stabilization at the operating point. Open-circuit emf's of the converter are estimated for instantaneous and temperature-stabilized cases. (D.L.C.)

30218 (NDA-2147-8) STUDIES RELATED TO PREDICTING COOLANT BEHAVIOR FOR FAST REACTOR

SAFETY. R. P. Stein (United Nuclear Corp., White Plains, N. Y.). Aug. 31, 1961. Contract AT(30-1)-2303(XIII). 77p.

Various problems related to the prediction of the behavior of liquid sodium coolant in fast reactors during abnormal operating conditions are studied. Included are two-phase flow characteristics, transient forced-convection heat transfer, transient fuel-element heat transfer, and the prediction of coolant behavior in a generalized fast reactor coolant channel. (auth)

30219 (NP-10711) DEPARTMENT OF REACTOR PHYSICS PROGRESS REPORT FOR PERIOD ENDING DECEMBER 1960. B. Tell, ed. (Aktiebolaget Atomenergi, Stockholm). June 1961. 37p. (R-27)

Plasma Physics. Experimental measurements were made for the interaction between a neutral gas and a plasma moving relative to each other, and for a strongly inhomogeneous magnetic field to ascertain whether the plasma is heated when passing the inhomogeneity. Theoretical studies were made of a full-scale fusion reactor based on the principles of a rotating plasma and a strongly inhomogeneous magnetic field. Theoretical Reactor Physics. Summaries are included of project calculations made for power and research reactors, heavy water reactors, and the Halden Boiling Reactor. Monte Carlo calculations and transport theory studies completed and in progress are outlined. Experimental Reactor Physics. Activities are discussed for work conducted: in the critical facility R-0; studies of fuels and lattices by successive substitution techniques; evaluations of R-3 fuel elements in the Production Development Pile at Savannah River; Zebra experiments; pressurized exponential experiments; determinations of the temperature coefficient of the resonance integral for uranium metal and oxide; measurements of resonance integrals of sodium, manganese, cobalt, copper-63 and -65, zirconium, molybdenum-98, and thorium metal and oxide rods; studies of neutron slowing in graphite and heavy water around a fission source; control of the purity of UO_2 and Zircaloy-2 for R-3 fuels; fast-fission factors of UO_2 rods; and Dancoff-Ginsburg corrections for the resonance integrals of clusters of rods. Neutron physics studies are discussed for scattering of slow neutrons from H_2O and D_2O , testing of the mechanical neutron monochromator, measurements of the neutron spectra of the R-1 reactor, flux distributions in the R-2 core, thermal diffusion parameters of heptane, and the slowing down time of fast neutrons in water. An outline is given of work being prepared for the 5.5 Mev Van de Graaff accelerator. A discussion is presented of work in progress in the construction of electronic equipment for use in the studies of neutron and reactor physics, and with the Van de Graaff accelerator. Numerical Analysis. A summary is presented of work completed and in progress for the Mercury computer, mixed reactor lattice calculations, reactor cell calculations, diffusion parameters, burn-up calculations, Monte Carlo methods, reactor kinetics, shielding studies, temperature distribution studies, uranium extraction from ores, and thermodynamic properties of D_2O . (B.O.G.)

30220 (ORNL-3166) GAS-COOLED REACTOR PROGRAM. QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1961. (Oak Ridge National Lab., Tenn.). Aug. 28, 1961. Contract W-7405-eng-26. 239p.

Activities are discussed for research in design investigations, and materials development and testing conducted in connection with the development of the EGCR. The discussions are given in terms of: reactor physics; reactor design studies; heat transfer and fluid flow investigations;

materials development; in-pile and out-of-pile testing of components and materials; and development of test loops and components. (B.O.G.)

30221 (TID-13670) REACTOR CONTAINMENT DESIGN STUDY. Bimonthly Progress Report, June 15, 1961 to August 15, 1961. (Sargent and Lundy, Chicago). Aug. 25, 1961. For Armour Research Foundation. Contract AT(11-1)-938. 12p. (SL-1857-5)

The economic and technical feasibility study of various reactor containment schemes was completed. A scope for a supplementary report evaluating a 300-Mwe internal steam separation reactor plant for four types of reactor containment was presented to the AEC. Design and cost evaluations were made of various components for a test facility. Piping diagrams for the test facility and heating system and also diagrams for the electrical system and air conditioning system were prepared. (auth)

30222 (WCAP-1433) REACTIVITY AND NEUTRON FLUX DISTRIBUTION STUDIES IN MULTI-REGION LOADED REACTOR CORES. W. J. Eich and W. P. Kovacic (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). June 1961. Contract AT(30-1)-2176. 252p.

The experimental and analytical procedures used in carrying out the Multi-Region Reactor Lattice Studies on reactivity and spatial distributions at two water-to-uranium ratios are described. The experiments were carried out in lattices having water-to-uranium ratios of 2.5:1 and 4.5:1 utilizing UO_2 fuel having enrichments of 1.6%, 2.7%, and 3.7% clad in stainless steel. The complete results and over-all conclusions based on the various experimental and analytical efforts are included. (auth)

30223 (WCAP-1434) MICROSCOPIC LATTICE PARAMETERS IN SINGLE- AND MULTI-REGION CORES: A COMPARISON OF THEORY AND EXPERIMENT. P. W. Davison, J. D. Cleary, B. Jennings, H. A. Risti, and G. H. Minton (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). June 1961. Contract AT(30-1)-2176. 187p.

Light water critical experiments are performed in order to measure microscopic parameters and conversion ratios in single region and multi-region cores containing slightly enriched, stainless steel-clad, UO_2 fuel rods. The experimental results are analyzed with multi-group codes, which are supplemented for the resonance energy region by a Monte Carlo code. Experimental and analytical results are presented, along with a description of investigations of discrepancies between theory and experiment. (auth)

30224 THE USE OF BURN-OUT ADSORBERS IN NUCLEAR REACTORS. V. S. Volkov, A. S. Luk'yanov, V. V. Chepkunov, V. P. Sheyakov, and V. S. Yamnikov. Atomnaya Energ., 11: 109-21 (Aug. 1961). (In Russian)

Both natural boron and enriched B^{10} are most frequently used as burn-out adsorbers in order to compensate for the high initial reactivity of a nuclear power reactor. The mechanical properties of irradiated and unirradiated boron stainless steel alloys are tabulated and compared. In general, radiation has a harmful effect on the properties of the boron alloy. The corrosion stability of irradiated and unirradiated boron alloys at 260°C are compared. The mechanical properties and corrosion stability in hot water are tabulated for boron-titanium alloys. Irradiation decreases the corrosion stability in hot water at 360°C, and decreases the plasticity of boron-zirconium alloys by a factor of five. The mechanical properties of irradiated and unirradiated dispersions of boron in titanium are presented. Cracks observed in irradiated boron alloys are probably

due to the evolution of helium. The various equations describing the burn-up of the adsorber as a function of the time of operation of the reactor, the distribution of boron in the fuel, and the axial distribution of the fuel and adsorber in the reactor are presented and discussed briefly. (TTT)

30225 THE STORED ENERGY IN THE GRAPHITE OF THE IR REACTOR LATTICE. V. I. Klimenkov and A. Ya. Zavgorodnii. Atomnaya Energ., 11: 126-32 (Aug. 1961). (In Russian)

Studies of the Windscale incident indicated that one of its causes was that during the annealing process the thermocouples used to control the reaction were placed in areas where the reactor temperature during operation was highest and not in areas of the maximum stored energy. An exact knowledge of the Wigner energy is thus of great practical interest and for this reason a study was undertaken to determine it in reactor lattice specimens obtained during the dismantling of the IR reactor. Representative specimens of the system were removed with a special drill after the material was exposed to an integrated flux of $2.2 \cdot 10^{21}$ n/cm². The Wigner energy was determined by means of 2 successive heatings of the specimens to 600-650°C while the total stored energy was obtained by means of combustion in a calorimeter used for solid fuel testing. The values obtained for the total stored energy, -320 and 540 cal/g, - agree well with published data. At the upper half of the annealing process the rate of the energy removal increases quite rapidly, exceeding the heat capacity of the graphite by a factor of 2. The average energy removal rate upon heating the graphite to 2000 to 2500°C was calculated at 0.33 to 0.25 cal/g degree. (TTT)

30226 GRUNDLAGEN UND ANWENDUNG DER KERN-TECHNIK. III. ENERGIE AUS KERNPROZESSEN. INGENIEURWISSEN 3/3a. (Fundamentals and Applications of Nuclear Technology. III. Energy from Nuclear Processes. Engineering Sciences No. 3/3a). Dusseldorf, VDI-Verlag GmbH, 1960. 376p.

The applications of energy from nuclear processes are discussed. Topics covered include uncontrolled nuclear processes, physics and technology of nuclear reactors, reactors for irradiation, transformation of nuclear energy into heat, temperature dispersion in the nuclear reactor, control of power reactors, instrumentation for nuclear power reactors, instrumentation for nuclear power stations, the manufacture of reactor metals, natural and enriched uranium in nuclear power stations, operational experience with Calder Hall Power Reactors, processing and storage of radioactive wastes from nuclear reactors, nuclear fusion as a possible energy source, and development of engineers in nuclear technology. (M.C.G.)

30227 IMPROVEMENTS RELATING TO CONTROL EQUIPMENT FOR NUCLEAR REACTORS. Leslie Carter Ludbrook and James Anthony Darke (to Associated Electrical Industries Ltd.). British Patent 876,028. (Aug. 30, 1961).

Improved equipment is designed for controlling the movement of reactor control rods. The equipment comprises a low-frequency a-c generator, a separate actuator motor associated with each of the control rods, and control circuits connecting the generator output to each of the motors. (D.L.C.)

30228 MOVING BED NUCLEAR REACTOR FOR PROCESS IRRADIATION. (to Esso Research and Engineering Co.). British Patent 876,401. Aug. 30, 1961.

A moving-bed reactor is designed for the process irra-

diation of liquid organic materials, particularly petroleum fractions. The bed contains fissile material, and moderation of the nuclear reaction is accomplished by the liquid material being treated. This process is particularly suitable for conversion of aliphatic hydrocarbons to a distillate lubricant fraction. (D.L.C.)

30229 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Richard Philip Kinsey and Leslie Mark Wyatt (to United Kingdom Atomic Energy Authority). British Patent 876,551. Sept. 6, 1961.

A reactor fuel element is described which may be used for service up to the order of 2000°C. The fuel element consists of a hollow member of non-metallic fuel material supported internally by a porous mass of non-fissile refractory material. The fuel element is enclosed in a protective sheath. Uranium dioxide and magnesium oxide may be used respectively as the fuel material and the refractory material. A description is also given for the train of interconnecting clusters which support the fuel elements in the reactor channels. The clusters consist of spiders. (N.W.R.)

30230 SAFETY LINK INCORPORATED IN AN ELASTIC SIDE RESTRAINT LINK FOR NUCLEAR REACTORS. Eric Victor Lockney (to Head, Wrightson & Co., Ltd.). British Patent 876,890. Sept. 6, 1961.

A restraining link for use in a reactor core or other structure which may be subject to expansion and contraction is described. The restraining link consists of a series of elastic links each comprising a series of tubular elements arranged to telescope one within the other. The links are pivotally connected to each other at their ends with safety links (tie bars). At least one of the tie bars is arranged within the telescopic links. The tie bars are coupled at their ends to the pivotal connections between the links so as to permit limited movement in an axial direction. Two different designs for tightening the tie bar are described, one being a nut and screw arrangement and the other a jacking means. (N.W.R.)

30231 PRESTRESSED CONCRETE ENVELOPE FOR AN ATOMIC PILE. Jean Bellier and André Coyne (to Commissariat à l'Energie Atomique). Canadian Patent 625,378. Aug. 8, 1961.

A prestressed concrete envelope or shield is designed which is prestressed in directions parallel and perpendicular to the main axis of symmetry of the envelope. The prestressing is achieved by rectilinear cables located inside of the envelope and having heads bearing against the outside walls. (D.L.C.)

Power Reactors

Refer also to abstract 28879

30232 (ACNP-6117) PATHFINDER ATOMIC POWER PLANT TECHNICAL PROGRESS REPORT, JANUARY 1961-MARCH 1961. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). July 15, 1961. For Northern States Power Co. and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. 105p.

Technical progress is reported of research and development in connection with the design of the Sioux Falls Power Reactor. Areas covered include fuel-material cladding, bonding, and irradiation testing; heat-transfer and fluid-flow studies; fuel-element manufacturing research and development; construction of nuclear handling tools; design of a low-enrichment superheater fuel element; vessel, structure, recirculation system, and control rod studies;

analyses of reactor and systems dynamics, and critical experiments; and initial stability and performance tests. (B.O.G.)

30233 (APAE-89) SM-2 FULL SCALE FLOW STUDIES TERMINATION REPORT. J. A. Christenson, W. M. S. Richards, and S. L. Davidson (Alco Products, Inc., Schenectady, N. Y.). July 30, 1961. Contract AT(30-3)-326. 198p.

Hydrodynamic flow studies were conducted on a full scale model of the SM-2 reactor vessel and core. The test fluid was water at 200 psi and 200°F. Test facility, model, and instrumentation design were discussed. Flow distribution in the stationary fuel elements, lattices, and control rods of the second pass was investigated. Pressure losses through the various core components were measured and compared with calculated values. The observed over-all pressure drop was 71 feet of water at 200°F, 31% higher than predicted, part of which was due to the presence of instrument leads. The element-to-element flow distribution varied approximately ±8% from the pass average. The channel-to-channel stationary element flow distribution varied approximately ±10% from the element average, and the control rod flow distribution varied from ±8.5% to +6.4 and -11.6% depending upon the rod location. These variations exceeded the original goals of ±10% and ±12% combined deviation for stationary and control rod elements respectively, but were satisfactory in relation to thermal design. There was no indication of unsatisfactory structural performance of any components under hydrodynamic loadings up to 130% of design values. (auth)

30234 (APEX-634) STRUCTURAL ANALYSIS OF THE ANP CONCENTRIC RING FUEL ELEMENT. D. R. Riley (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). June 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 20p.

During the development of the direct air cycle concentric ring fuel element it was necessary to make a detailed structural analysis of the configuration. The analytical formulation of the structural analysis and experimental verification are described. (auth)

30235 (APEX-747) D140E1 CONTROL NUCLEAR SENSORS. R. L. Treinen (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). July 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 24p.

The designs of the D140E1 control nuclear sensors and the evaluation testing accomplished are described. Sensor packaging for mounting to the reactor shield assembly is discussed as are problem areas and recommendations. (auth)

30236 (CF-61-8-86) THORIUM BREEDER REACTOR EVALUATION. PART I. FUEL YIELDS AND FUEL CYCLE COSTS OF A TWO-REGION MOLTEN SALT BREEDER REACTOR. W. L. Carter and L. G. Alexander (Oak Ridge National Lab., Tenn.). Aug. 18, 1961. 97p.

The Molten Salt Breeder Reactor (1000 Mwe station) is capable of giving fuel yields of about 7%/yr (double time (DT) = 14 years) at a fuel cycle cost of approximately 1.5 mills/kwhr. At fuel yields of 1 to 2%/yr (DT = 100 to 50 years), the fuel cycle cost extrapolates to 0.65 mills/kwhr; at 4%/yr (DT = 25 years), the fuel cycle cost is about 0.85 mills/kwhr. All systems are optimized with respect to fuel cycle processing times. The effects on breeding performance of uncertainty in the epithermal value of η -233, of uncertainty in the Pa^{233} resonance integral, of the variable Th inventory in the fertile stream, and of the inclusion of ZrF_4 in the reactor fuel are evaluated. (auth)

30237 (CVNA-91) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC., RESEARCH AND DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT FOR THE PERIOD APRIL-MAY-JUNE 1961. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). 239p.

A report is presented of research and development being carried on at the Parr Shoals reactor. Projects discussed include nuclear design, pressure tube assembly development, irradiation experiments, materials and components development, plant system development, and critical experiments. (D.L.C.)

30238 (DLCS-1470106) DETERMINATION OF REACTOR COOLANT SYSTEM PRESSURE DROP. CORE 1, SEED 2. Test Evaluation T-550129. (Duquesne Light Co., Shippingport, Penna.). First issue, Aug. 3, 1961. 26p.

The reactor coolant system pressure drop and flow characteristics are determined at a nominal 1800 psig and 500°F. The pumping rates of the coolant pumps, as well as the pressure drops across the reactor vessel, the coolant loops, and the heat exchangers are measured at slow and fast pumping speeds. (T.F.H.)

30239 (DLCS-2130201) MODIFIED PURIFICATION SYSTEM PERFORMANCE TEST. CORE 1, SEED 2. Test Results T-641124-A. Section 2. (Duquesne Light Co., Shippingport, Penna.). First issue, July 21, 1961. 24p.

The effectiveness of purification in controlling plant radioactivation rates was determined through comparison of the actual effects produced from plant operation with and without purification. With the purification system in service, there was no appreciable difficulty in maintaining the reactor coolant within reference water specifications. In addition, there was no discernible increase of crud deposition in the coolant system as determined by direct radiation measurements of the purification hairpin loop. However, without demineralization as a controlling agent, the gross non-volatile gamma activity levels of the reactor coolant increased and the specific activities of long-lived fission products were at higher levels. Although the general levels of water-borne activities increased during the test period, the associated plant systems did not exceed their limits. (auth)

30240 (DLCS-2340107) RADIATION LEVELS IN THE VICINITY OF THE PURIFICATION DEMINERALIZERS. CORE 1, SEED 2. Test Evaluation T-641306. (Duquesne Light Co., Shippingport, Penna.). First issue, May 25, 1961. 11p.

Measurements were made to determine the extent of activity build-up inside the 1 AC and 1 BD purification demineralizer concrete enclosures. Radiation levels were obtained at 6-in. intervals from 6 to 17.5 ft below the top of the concrete shield on the 1 AC demineralizer and from 0.5 to 24.5 ft on the 1 BD demineralizer by lowering the probe through the 3-in. pipe on top of the concrete enclosure. The results indicated that the long-lived activity in the purification demineralizers had decreased considerably, since the previous test, with the addition of new resin. (M.C.G.)

30241 (DLCS-3280102) HYDROGEN DISTRIBUTION AND LEAK RATE FROM THE REACTOR COOLANT SYSTEM. Test Evaluation-RNI-31A. (Duquesne Light Co., Shippingport, Penna.). First issue, Aug. 9, 1961. 14p.

Hydrogen is injected into the coolant to a concentration of about 60 cc/kg. The decrease in H concentration is measured as a function of time, and of the point of addition. The H may be added at the inlet or outlet sides of either of two ion exchangers. The decontamination factors of these

ion exchangers are not affected by the presence of the H. The time required for the H concentration to drop to half its original value varies between 118 and 172 hr. (T.F.H.)

30242 (DLCS-3360102) PERIODIC CALIBRATION OF PRESSURE INSTRUMENTATION. CORE 1, SEED 2. Test Evaluation T-643718. Section 1. (Duquesne Light Co., Shippingport, Penna.). First issue, Aug. 3, 1961. 18p.

The pressure measuring instrumentation of the reactor coolant loop, the reactor, and the pressurizer is calibrated at 250 to 2000 psig. The narrow range instrumentation for the pressurizer cannot be calibrated by the approved procedures to the required accuracy (± 5 psi). The other instruments, however, are calibrated to their required accuracies (± 25 psi). (T.F.H.)

30243 (DLCS-3360201) CALIBRATION OF PRESSURIZER NARROW RANGE PRESSURE INSTRUMENTATION. CORE 1, SEED 2. Test Evaluation, T-643718. Section 2. (Duquesne Light Co., Shippingport, Penna.). First issue, Sept. 15, 1961. 6p.

The pressurizer narrow range pressure measuring instrumentation was calibrated. The "as found" data of the pressurizer narrow range indicator were within the accuracy limits stated in the approved test procedure. However an adjustment was necessary on the recorder. The "as left" data showed that the recorder was within calibration limits of ± 5 psi for pressures between 1500 and 1850 psig. (M.C.G.)

30244 (DLCS-3370102) PERIODIC CALIBRATION OF REACTOR PLANT FLOW INSTRUMENTATION. CORE 1, SEED 2. Test Evaluation, T-643720. Section 1. (Duquesne Light Co., Shippingport, Penna.). First issue, Sept. 15, 1961. 14p.

Tests were made to determine and correct any calibration drift or error in the reactor coolant flow instrumentation. The 1A and 1C reactor coolant loop flow instrumentation was calibrated to an accuracy of $\pm 1\%$ of full scale over the entire span. The 1B and 1C flow instrumentation was calibrated to an accuracy of $\pm 1\%$ of full scale over the normal operating range. Above this range, both had calibration errors of 2.8% of full scale. Calibration curves are presented. None of the vent valves on the differential pressure cells that were calibrated indicated leakage. (M.C.G.)

30245 (DLCS-3410107) EXTERNAL RADIATION LEVELS OF REACTOR COOLANT LOOP PIPING AND COMPONENTS. CORE 1, SEED 2. Test Evaluation T-612076-A. Section 1. (Duquesne Light Co., Shippingport, Penna.). First issue, July 21, 1961. 31p.

The buildup of corrosion product activity in the reactor coolant loop piping and components is measured at 2, 30, and 100 hr after reactor shutdown. It is found that the "hot spots" in the system are in the same locations and have the same intensities as established by previous performances of the test. (T.F.H.)

30246 (DLCS-3410201) EXTERNAL RADIATION LEVELS OF REACTOR COOLANT PIPING AND COMPONENTS. Test Evaluation T-612076-A. Section 2. (Duquesne Light Co., Shippingport, Penna.). First issue, Aug. 24, 1961. 12p.

Equipment and procedures are described which were used to determine the contributors to the radiation levels in the steam generator and the radiation levels at the end of Core 1, Seed 3. The major contributor to the radiation level in the steam generator was the tube sheet on the inlet side of the heat exchanger. The radiation levels covered by this period were considered to be essentially stable and should remain so until the end of Seed 3. (B.O.G.)

30247 (DLCS-3500102) FEDAL SYSTEM (CHECKOUT TEST). CORE I, SEED 2. Test Evaluation T-643731. Section 1. (Duquesne Light Co., Shippingport, Penna.). First issue, Aug. 1, 1961. 11p.

A checkout test is run on the FEDAL (Failed Element Detection and Location) system, in order to determine its reliability. The count rate is checked with a test oscillator, and the neutron sensitivity is checked with a calibrated Pu-Be neutron source. (T.F.H.)

30248 (DLCS-3500103) FEDAL SYSTEM (CHECKOUT TEST). CORE I, SEED 2. Test Evaluation. Section 1. (Duquesne Light Co., Shippingport, Penna.). First issue, [Aug. 22, 1961]. 9p.

An evaluation was made to determine if the Failed Element Detection and Location (FEDAL) System (checkout test) is operating properly so that it yields reliable data. The test was run with the station at normal operating temperature and pressure conditions of 500°F and 1785 psig. The monitor power supplies, amplifiers, counting units, and calibrating units were energized at least one hour prior to the test. The flow rates from the 113 blanket assemblies were checked on Monitor No. 1. The background activity was checked. A neutron sensitivity check was performed. (M.C.G.)

30249 (DLCS-3500260) FEDAL SYSTEM OPERATION DURING STATION START-UP. CORE I, SEED 2. Test Evaluation T-643734. Section 1. (Duquesne Light Co., Shippingport, Penna.). First issue, June 14, 1961. 16p.

The FEDAL system is used to monitor blanket elements at core locations E-3 and E-13 during startup, from 0 to 31 Mw. These elements are concluded to be intact. (T.F.H.)

30250 (DLCS-3590601) 1D MAIN COOLANT PUMP (ALLIS-CHALMERS NO. 80) POWER SUPPLY CHECK. Test Evaluation. Section 6. (Duquesne Light Co., Shippingport, Penna.). First issue, Aug. 22, 1961. 39p.

The operating characteristics of the 2400 volt three-phase bus of the 1D coolant loop are determined under various load conditions. It is found that the three phases are balanced under most of these loads; that the potential never drops below 2300 v with steady loads, and never drops below 2200 v during the startup of the 1D pump; and that the bus has sufficient capacity to start the 1D coolant pump under the most adverse load conditions. (T.F.H.)

30251 (DLCS-3810101) PWR EMERGENCY PLAN DRILL NO. 1 (MINOR AIRBORNE RELEASE OF RADIOACTIVITY). CORE I, SEED 2. Test Evaluation T-641331. Section 1. (Duquesne Light Co., Shippingport, Penna.). First issue, July 7, 1961. 31p.

The procedure followed as a consequence of a simulated rupture of the radioactive waste disposal system gas decay drum is described. The rupture is assumed to allow a minor gaseous release of radioactivity. The duties and performances of various key personnel, both on- and off-site, are discussed and analyzed. The adequacy of the emergency procedure is evaluated. (T.F.H.)

30252 (DLCS-3810201) PWR EMERGENCY PLAN DRILL NO. 2 (MINOR WATERBORNE RELEASE OF RADIOACTIVITY). Test Evaluation, T-641332. Section 2. (Duquesne Light Co., Shippingport, Penna.). First issue, Sept. 11, 1961. 10p.

The adequacy of the PWR Emergency Plan as it applies to a minor waterborne release of radioactivity was evalu-

ated. The test was carried out and the actions of the survey team, the Radioactive Waste Disposal System Operator, the Station Operating Engineer, and the AEC Duty Representative are described. It was found that the plan, in general, is an adequate procedure for the emergency. (M.C.G.)

30253 (GEAP-3633) STEAM-COOLED REACTOR EVALUATION. STUDY OF 300 MW(e) ONCE-THROUGH SUPERHEATER REACTOR. R. T. Pennington (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 1961. Contract AT(04-3)-189. 222p.

The conceptual design of a once-through superheat reactor is described. The reactor complex is for a 300-Mw(e) power plant. The work is limited to the accumulation of design and performance information on the nuclear portion of the plant. The characteristic feature of the reactor concept is the once-through reactor coolant flow arrangement in which reactor feedwater is heated through the subcooled state boiling state, and superheat state in a continuous flow arrangement without separation of the phases, recirculation, or extraction. (J.R.D.)

30254 (GEAP-3646) CALCULATION OF DOPPLER COEFFICIENT AND OTHER SAFETY PARAMETERS FOR A LARGE FAST OXIDE REACTOR. P. Greebler, B. A. Hutchins, and J. R. Sueoka (General Electric Co. Atomic Power Equipment Dept., Schenectady, N. Y.). Mar. 23, 1961. Contract AT(04-3)-189. 43p.

Several safety parameters are calculated for a large, fast, Na-cooled, oxide-fueled reactor. The Doppler coefficient is studied as regards its effect on the reactivity during a power excursion, and its dependence on the neutron spectrum, on the concentrations of U^{238} , Pu^{239} , and Pu^{240} , on spatial temperature and power distributions, and on temperature. Other parameters studied include the Na temperature coefficient of reactivity, and the reactivity insertion caused by total Na loss; reactivity coefficients caused by thermal expansion of fuel and steel cladding; the excess operating reactivity; and the reactivity caused by a fuel slump. The effects of a Be reflector on neutron lifetimes are determined. The safety aspects are balanced against economic considerations. (T.F.H.)

30255 (GEAP-3737) FLOOD SAFETY OF THE MIXED SPECTRUM SUPERHEATER. A. B. Reynolds (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). May 25, 1961. Contract AT(04-3)-189. 47p.

Calculations are presented which show that the reactivity effect of flooding and unflooding the fast superheating section of the Mixed Spectrum Superheater can be made small by the addition of epithermal poisons to the superheater. The reactivity effects of flooding superheater sections ranging in size from 1.25 to 3.5 ft cubes and containing U^{235} oxide or Pu^{239} oxide fuel and various amounts of the epithermal poison europium were calculated. Reactivity changes during several postulated flooding processes are given. Methods for determination of fissile and fertile material and poison cross sections in the resonance region are discussed. (auth)

30256 (MND-M-1857) PM-1 TASK 5, SUBTASK 5.8—LOCAL BOILING HEAT TRANSFER TESTS. SINGLE TUBE HEAT TRANSFER AND PRESSURE DROP TESTS. S. Frank, J. Jicha, and M. Norin (Martin Co. Nuclear Div. Baltimore). May 1961. 120p.

A program is described which is devoted to heat transfer and pressure drop measurements on single tube sections with coolant flow only on the inside. The tests were conducted on simulated PM-1 fuel elements. Data are included and data reduction methods are discussed. (J.R.D.)

30257 (NAA-SR-5211) COOLANT FLOW AND OUTLET TEMPERATURE COMPUTER-MONITORS FOR THE HALLAM NUCLEAR POWER FACILITY PLANT PROTECTIVE SYSTEM. H. Schlein (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 15, 1961. Contract AT(11-1)-GEN-8. 41p.

The design and application of two computers for the HNPf protective system are discussed. One of the computers calculates the ratio of sodium flows in the primary and secondary loops; it then checks the result against two sets of limit curves and activates relays to show where the calculated ratio falls with respect to the two curves. The other computer calculates the predicted reactor outlet temperature, checks the results against three sets of limit curves and activates relays to show the calculated outlet temperature with respect to the three curves. (auth)

30258 (NAA-SR-6100(Vols. I and II)) STEAM-COOLED POWER REACTOR EVALUATION GRAPHITE-MODERATED, BOILING WATER, STEAM SUPERHEAT REACTOR. VOLUMES I AND II. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1961. 217p.

A conceptual reference design of a 318-Mw(e) Graphite Moderated Boiling and Superheating Reactor (GBSR) is described. In this concept, the coolant is light-water-and-steam in pressure tubes which pass through the graphite moderator. Fuel slugs of uranium carbide in a graphite matrix are in channels in the moderator, separated from the coolant by the graphite. The reactor is designed for refueling under load and for direct maintenance. Turbine throttle steam conditions are 1800 psig/1000°F with 1000°F reheat which yields a net cycle efficiency of 41.8%. Descriptions of the design of the reactor core, fuel handling system, control rod and drive system, piping system, control and instrumentation system, auxiliary reactor equipment systems, electrical systems, and the reactor plant facilities are included. In addition, the plant operation is described during normal and abnormal operating conditions. A discussion of potential cost savings and a description of the required research and development are presented. (auth)

30259 (NAA-SR-6118) HALLAM EXPONENTIAL EXPERIMENTS USING U-Mo FUEL. O. R. Hillig (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 15, 1961. Contract AT(11-1)-GEN-8. 52p.

The results of exponential experiments with graphite-moderated lattices containing multirod fuel clusters are presented. Three lattices of different spacings where the fuel clusters form regular hexagons, and one square lattice were studied. Fuel clusters were of a uranium molybdenum alloy. Some measurements were also made using a single uranium carbide fuel cluster and a uranium molybdenum fuel element of lower U^{235} enrichment. The results are presented for measurements of thermal neutron diffusion length (L) of the moderator in each assembly, material buckling (B^2) for the various lattices, detailed neutron flux distributions, thermal utilization, (f) and the ratios involved in resonance escape probability (r_p) and fast effect (r_e). (auth)

30260 (NAA-SR-Memo-4264) PARAMETER SURVEY OF THE AVERAGE NUCLEAR POWER GENERATION IN THE HNPf RARE EARTH CONTROL ROD POISON COLUMN ASSEMBLY. R. Karcher (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 20, 1959. Includes Appendix A: GAMMA-

RAY ESCAPE PROBABILITY CODE DESCRIPTION.

The control rod capture gamma power generation from capture gammas originating in the rare earth poison ring was calculated as a function of poison wall thickness and poison density. The results are in good agreement with these of SRE In-pile Poison Ring Test No. 2. For an assumed reactor power level of 20 Mw, the average power generation in the experimental poison assembly is calculated to be 1.53 kw/ft, in agreement with the experimental value of 1.50 kw/ft. (D.L.C.)

30261 (NAA-SR-Memo-6332) SECOND LCTL TEST OF HNPf MODERATOR CANS. E. C. Phillips (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 20, 1961. 25p.

The Hallam Power Reactor moderator can incorporating a 6-segment graphite log and a $\frac{1}{8}$ hard Type 304 stainless steel sheath was tested in sodium at 1000°F and found to be suitable for use in the reactor. Three full-size moderator cans were fabricated; can 3 was essentially identical to a production HNPf can while cans 1 and 2 differed in that they utilized annealed 304 stainless steel for the sheath. In addition, can 1 did not contain a zirconium-sponge getter and utilized a single unit log rather than a log of 6 separate segments. Cans 1 and 2, installed in the core tank of the LCTL, were slowly heated in a gas atmosphere. The strains which developed in the can sheaths, because of differential expansion between the graphite logs and the sheaths, were measured. Inconclusive strain data on can 2 were obtained and data for 6-segment cans were subsequently obtained on can 3. Strains developed in a single-log can were approximately 6 times higher than those developed in the 6-segment can. In addition to the friction-strain tests, the cans were thermally cycled in sodium in each phase of the program. These exposures demonstrated that the cans do not leak, the zirconium getter becomes effective above 850°F, and the $\frac{1}{8}$ hard material develops less permanent deformation than annealed material. (M.C.G.)

30262 (NDA-2161-2) STEAM-COOLED POWER REACTOR EVALUATION, STEAM-COOLED D_2O -MODERATED REACTOR. G. Sofer, R. Hankel, L. Goldstein, and G. Birman (Nuclear Development Corp. of American, White Plains, N. Y.). Apr. 15, 1961. Contract AT(30-1)-2303. 72p.

A conceptual study is presented of a D_2O -moderated, steam-cooled power reactor, in which the coolant makes two passes through the core. On the first pass, the H_2O enters the core as a liquid-steam dispersion (fog), and the second pass superheats the steam. U fuel is used with enrichments up to 1.05% U^{235} . Several versions of this reactor concept are examined at 40 and 300 Mw(e), using present and future materials for the various components. (T.F.H.)

30263 (NP-10339) NOGLE THERMODYNAMISKE BETRAGTNINGER. (Brief Thermodynamic Considerations). H. Weldingh (Danish Assn. for Industrial Development of Atomic Energy, Hellerup). Jan. 1959. 9p.

Some results of a thermodynamic study of the steam cycle for the Danish BETA reactor project are reported. The principal deviations of the steam cycle from conventional installations are tabulated, and the simplified thermal process is analyzed. (J.S.R.)

30264 (ORNL-3167) HOMOGENEOUS REACTOR PROGRAM PROGRESS REPORT FOR PERIOD FROM DECEMBER 1, 1960 TO MAY 31, 1961. (Oak Ridge National Lab., Tenn.). Sept. 6, 1961. Contract W-7405-eng-26. 130p.

Homogeneous Reactor Test. Four HRT runs were performed to study the reactor behavior with downward core flow. The upper patch was found to have fallen out, resulting in an increase in core-to-blanket mixing. The reactor will not be operated again. In the HRT processing plant, the development of a process for removing Ni and other soluble contaminants from fuel solutions by peroxide precipitation was continued, and efficiency tests of stack-filter iodine traps were performed. Power-trace data and computer analysis of a HRT flow model indicate that the HRT power fluctuations were caused by flow perturbations. A flow diffuser was developed to reduce core wall temperature and core power oscillations. Temperature transients due to density changes were determined. **Engineering Development.** ThO_2 slurries were found to show a slip effect in small-bore capillary tubes, while chemically dispersed slurries showed no such effect. Slurry friction factors in turbulent flow were correlated with Reynolds numbers. **Solution Fuels.** The stability of Pa tracers in $\text{Th}(\text{NO}_3)_4$ - HNO_3 solutions was studied at 21 to $>200^\circ\text{C}$. The effect of inorganic ions on the solubility of H_2 in H_2O is shown graphically. The solubility and nature of UO_3 hydrates in H_2SO_4 solutions were studied at 150 to 300°C . The effect of pressure on the liquid-liquid immiscibility temperature of UO_2SO_4 - H_2SO_4 - H_2O solutions was determined. Critical temperatures and liquid-liquid immiscibility boundaries were determined for UO_3 - CuO - SO_3 - D_2O , UO_3 - NiO - SO_3 - D_2O , and UO_3 - CuO - NiO - SO_3 - D_2O systems. The solubility of ThO_2 in HNO_3 solutions was determined at 150 and 200°C . A UO_2SO_4 - CuSO_4 - D_2SO_4 - D_2O solution was circulated for 553 hr at 360°C in a Ti loop to study its stability and corrosive effects on Zircaloy-2. Sorption of U from a similar fuel solution on Zircaloy-2 surfaces at 360°C was studied, and recombination rates of radiolytic gases in the irradiated solution were determined. The activation energies of anodic and cathodic reactions were determined in Zircaloy-2 by electrochemical measurements. **Slurry Fuels.** Radiation effects on ThO_2 pellets and ThO_2 - UO_2 slurries were studied. Development of Pd as a gas recombination catalyst for O_2 and D_2 in slurries is described. Some physical and attrition properties of Code P-82 ThO_2 pellets were measured. In-pile slurry autoclave experiments were performed to compare the radiation effects on agitated ThO_2 - UO_2 slurries with those for loop slurries. Corrosion of Zircaloy-2, type 347 stainless steel, and Ti alloys 45A and 110AT by in-pile ThO_2 - UO_2 slurries was evaluated. **Fuel Manufacture.** Development of the sol-gel process for preparing large ThO_2 particles is described. **Metallurgy.** The effect of preferred orientation and texture on the Knoop microhardness of Zircaloy-2 was studied. A pressed-cube technique was developed for fabricating spherical ThO_2 pellets. **Analytical Chemistry.** An amperometric method used for Th titration with EDTA is found to be applicable to the determination of Cu and some rare earth elements. (D.L.C.)

30265 (SL-1874) HEAVY WATER REACTOR PLANT LEAKAGE. W. A. Chittenden and G. F. Hoveke (Sargent and Lundy, Chicago). June 30, 1961. Contract AT(38-1)-213. 78p.

The leakage rates of D_2O past turbine shaft seals, pump shaft seals, and valve stems are measured. The turbine seal leakage is about 0.65 lb/mo; the pump seal leakage is 7 or 8 lb/yr; and the valve stem leakage is 5 to 19 lb/yr. A description of sealing methods is presented. (T.F.H.)

30266 (SRO-58) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, AUGUST 1961. (Savannah River Operations Office, AEC). 22p.

Progress in various heavy water power reactor projects is reported. The development of an on-power refueling machine and an adapter valve for the CANDU reactor is described. The construction progress of the Heavy Water Components Test Reactor is discussed in detail. The development status of the Parr Shoals Reactor is outlined. (D.L.C.)

30267 (TID-7614(p.4-31)) APPLICATION OF URANIUM MONOCARBIDE TO POWER REACTORS. D. I. Sinizer (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.).

A description of UC is presented and the developmental work being carried on by AEC contractors is described. Included are discussions of out-of-pile properties such as those illustrated by phase diagrams and metallography, mechanical properties, and compatibility with coolants and cladding. It is noted that more development is required, however, the behavior shown by UC thus far indicates its usefulness in high temperature reactors. (J.R.D.)

30268 (TID-12710) MONTHLY OPERATING REPORT, APRIL 1961. (Duquesne Light Co., Shippingport, Penna.). Contract AT(11-1)-292. 52p.

30269 (TID-12747) STEAM-COOLED POWER REACTOR EVALUATION CAPITAL AND POWER GENERATION COSTS. (Kaiser Engineers Div., Henry J. Kaiser Co., Oakland, Calif.). Mar. 17, 1961. Contract AT(04-3)-334. 261p. (KE-60-31)

Estimated capital and power generation costs are compared for nine steam-cooled power reactor concepts. The reactor concepts studied are the Graphite-Moderated Boiling and Superheating Reactor (GBSR), the Integral Boiling and Superheating Reactor (IBSHR), the Integral Nuclear Superheat Reactor (ISR), the Mixed Spectrum Superheater Reactor (MSSR), the Once-Through Superheat Reactor (OTSR), the Pressure Tube Superheat Reactor (PTSR), the Steam-Cooled D_2O -Moderated Reactor (SCDMR), the Steam-Cooled Fast Breeder Reactor (SCFBR), and the Separate Superheater Reactor (SSR). Each of these is analyzed at a nominal plant size of 300 Mw(e); in addition, the ISR, the SCDMR, and the SCFBR are studied at 40 Mw(e). (auth)

30270 (TID-12882) MONTHLY OPERATING REPORT, MARCH, 1961. (Duquesne Light Co., Shippingport, Penna.). Contract AT-11-1-292. 50p.

The monthly activities are summarized covering operations, activity schedules, refueling, maintenance, test programs, and training programs. (T.F.H.)

30271 (TID-13511) PERIODIC CALIBRATION OF REACTOR PLANT DIFFERENTIAL PRESSURE INSTRUMENTATION. CORE 1, SEED 2. Test Evaluation T-643719. Section 1. (Duquesne Light Co., Shippingport, Penna.). First issue, Aug. 3, 1961. 18p. (DLCS-3420102 and -03).

A calibration is performed on the differential pressure instrumentation of the reactor coolant pump, the heat exchanger, and the reactor vessel. These instruments are calibrated to $\pm 1\%$ at full scale, and malfunctioning instruments are removed from service. (T.F.H.)

30272 (TID-13512) FEDERAL SYSTEM (OPERATIONAL TEST). CORE 1, SEED 2. Test Evaluation T-643731. Section 3. (Duquesne Light Co., Shippingport, Penna.). First issue, Aug. 18, 1961. 31p. (DLCS-3500307 and -08).

The delayed neutron activity of 113 fuel blanket assemblies in the PWR is monitored by the FEDAL system. The ratio of the activity of each assembly to the average activity is measured, and the relative distributions of the major delayed neutron emitters (I^{137} and Br^{81}) are determined. (T.F.H.)

30273 (TID-13566) SPECIFICATION FOR EXPERIMENTAL GAS COOLED REACTOR. Specification No. RB-1. BURST SLUG DETECTION SYSTEM. D. F. Luse. July 12, 1960. Includes Specification No. RB-2. BURST SLUG DETECTION INSTRUMENTATION SYSTEM. D. F. Luse. May 6, 1960. Addendum No. 1. Feb. 9, 1961. Addendum No. 2. Mar. 30, 1961. Addendum 3. Apr. 25, 1961. (Allis-Chalmers Mfg. Co. Nuclear Power Dept., Washington, D. C.). For Kaiser Engineers. Div. of Henry J. Kaiser Co., Oakland, Calif. 56p.

Specifications are presented for the functions, design, manufacture, installation, and testing of the Burst Slug Detection system of the EGCR. In the system, samples of the coolant gas are taken sequentially from each of the fuel channels and passed through an electrostatic precipitation monitor. (D.L.C.)

30274 (WAPD-234) SUMMARY OF CALCULATIONAL AND EXPERIMENTAL PHYSICS RESULTS FOR SHIPPINGPORT PWR-1 SEED 1. R. P. Christman and D. H. Jones (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Jan. 1961. Contract AT-11-1-GEN-14. 76p.

Calculational and experimental physics results for the Shippingport PWR Reactor are summarized, to demonstrate the ability of one, two, and three-dimensional diffusion theory models to predict reactor parameters and core behavior over the reactivity lifetime of the initial fuel loading. Calculated and experimental values of the temperature and pressure coefficients of reactivity, xenon transient behavior, core power distribution, and reactivity loss rates are compared. Model tests are able to calculate the reactivity lifetime reliably to within 10% of the measured reactivity lifetime. One-, two-, or three-dimensional calculations predict the value of the temperature coefficient to within 30% over core lifetime. The principal merit of the three-dimensional model is the prediction of the changing core power distribution caused by fuel depletion and control rod motion over lifetime. Temperature coefficients can be inferred from a combination of measurements of rod position during full-power operation and rod worths during xenon transients. Major sources of error in the calculational models may be caused by lack of knowledge of the fission product cross section as used in the depletion codes. The behavior of the blanket power fraction is in agreement with prediction within the accuracy of the measurements. (auth)

30275 (WAPD-PWR-TE-83) SHIPPINGPORT PWR-1 SEED 2 PHYSICS TEST RESULTS FROM 3600 EFPH TO 6200 EFPH. Test Evaluation. G. H. Saito and J. H. Leonard (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). June 23, 1961. 26p.

Measurements are made of the control rod positions for criticality at ambient temperature and at 500°C; the temperature coefficient at 100% power; and the reactivity coefficients, xenon transients, and reactivity lifetime. (T.F.H.)

30276 (AEC-tr-4611) THE SELECTION OF THE OPTIMUM PARAMETERS FOR A NUCLEAR POWER STATION. A. Ya. Kramerov. Translated from Atomnaya Energ., 10: 211-21(1961). 29p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 15, abstract no. 17849.

30277 STUDY OF SPENT FUEL ELEMENTS OF THE FIRST (SOVIET) ATOMIC POWER STATION. A. P. Smirnov-Averin, V. I. Galkov, V. I. Ivanov, V. P. Meshcheryakov, I. G. Sheinker, L. A. Stabenova, N. N. Krot, and A. G. Kozlov. *Atomnaya Energ.*, 11: 122-5 (Aug. 1961). (In Russian)

The FAPS fuel elements used for periods of 104 and 445 days of actual operation in the reactor showed a marked increase in diameter; at the higher burnup value the difference between the diameters of the elements at the center and at the ends decreases indicating saturation during the swelling process. A later observation made after 557 days of operation shows that the diameter remains constant after it reaches its maximum value. For radiochemical measurements the samples taken at various positions lengthwise from the element were dissolved in HNO_3 . The α -, β -, and γ -activities of these solutions were compared with similar fuel specimens with a 12.5% burnup. In the latter case the ratio of the β - and γ -activities had a constant value while at higher burnup rates it changed with the position on the length of the element; this is probably due to the activation of most of the fission product during extended operation of the reactor. The activity of the central portion of the external stainless tube was about 30% higher than the corresponding portion of the inner tube, probably because of a difference in the neutron spectrum. The calculated burnup level was 53%. The isotopic composition of the element per 1 ton of U was: Pu^{239} - 4.10 kg, Pu^{240} - 1.53 kg, Pu^{241} - 0.64 kg, Pu^{242} - 0.20 kg, and Cm^{242} - $2.73 \cdot 10^{-3}$ kg. (TTT)

30278 POTENTIAL APPLICATION OF SALINE WATER CONVERSION IN AUSTRALIA WITH PARTICULAR REFERENCE TO THE USE OF NUCLEAR HEAT. L. S. Herbert and H. R. C. Pratt. *Australasian Engr.*, 65-72 (July 1960).

A brief survey is given of proposed methods for the production of potable water from saline waters. It is concluded that vapor recompression distillation, electrodialysis, and in some cases solar distillation, represent the most suitable processes for domestic units, capable of outputs of about 50 to 500 gal/day. For large-scale plants, suitable for supplying large communities, distillation methods appear most suitable on the basis of existing technology, although electrodialysis would be applicable to brackish waters with salt contents below 5000 ppm. Freezing methods also show considerable promise. Preliminary design and cost studies are given for multistage flash evaporation plants employing nuclear reactors as the heat source, both without and with concurrent power generation by means of back-pressure turbines. It is shown that plants based on the 150 and 275 Mw(e) gas-cooled reactors currently being installed in Britain would produce respectively 44 and 80 million gallons per day of water together with 30 and 63 Mw of surplus power; the larger of these plants would be capable of providing a city of 500,000 population with the whole of its water and about 25% of its installed power capacity. Data are also given for a small plant based on a 50 Mw(th) pressurized water reactor employing U.S. enriched fuel. In this case 4,000,000 gallons per day of water would be produced together with 2.6 Mw of surplus power. (auth)

30279 6th REPORT ON NUCLEAR POWER. A Special Report. W. L. Felsen, ed. *Elec. World*, 155: No. 21, 67-82 (May 22, 1961).

Future developments and production costs in the nuclear

power field are discussed. It is shown that caution has been observed in this field and that the field will grow more rapidly as costs come down and safety features are better known. A survey is given on the activities of utility companies in respect to their interest, participation in training programs, and future developments. A chart is provided that compares the steam pressures and temperatures of the nuclear power plants the United States has in operation, under construction, or in the design stage. A table is provided which lists the 24 US nuclear power plants producing at least a megawatt of electric power. The characteristics, costs, and owner of each plant are given. (N.W.R.)

30280 DEVELOPMENT OF THE BBC-KRUPP HIGH-TEMPERATURE REACTOR. Rudolf Schulten, Andreas Setzwein, and Gerhard Wittchow (Arbeitsgemeinschaft BBC-Krupp, Mannheim, Ger.). *Elektrotech. Z.*, B13: 55-6 (1961). (In German)

Development problems involved in the BBC-Krupp High-temperature Reactor are discussed. Brief descriptions are given of the fuel, core, coolant gas, steam generator, protection container, and economy. A schematic diagram and a list of the characteristics of the reactor are given. (N.W.R.)

30281 CONSTRUCTION CHARACTERISTICS OF THE BBC-KRUPP HIGH-TEMPERATURE REACTOR. Andreas Setzwein, Helmut Braun, and Gerhard Wittchow (Arbeitsgemeinschaft BBC-Krupp, Mannheim, Ger.). *Elektrotech. Z.*, B13: 57-62(1961). (In German)

The physical and technical construction characteristics of the BBC-Krupp Reactor are given. Some detail is given of the construction layout and the arrangement of the reactor components and systems. A description is given of the fuel loading and unloading system and the gas cooling system and equipment. (N.W.R.)

30282 ON THE RESONANCE INSTABILITY OF EBR-1. Yoshie Ebizuka (Tokyo Inst. of Tech.), Waichiro Kawakami, and Masuo Shindo. *J. At. Energy Soc. Japan*, 3: 522-30 (July 1961). (In Japanese)

The experimental Breeder Reactor, EBR-1, received considerable attention when an oscillatory instability under abnormal operating conditions was observed. Investigations of kinetic characteristics revealed that a prompt positive power coefficient of reactivity, which is generally believed due to the bowing of fuel elements, and a more delayed negative power coefficient exist. Controlled oscillator measurements were performed with the result that EBR-1 exhibited resonance instability. Though a number of theoretical models of the coefficients was presented to study the instability, they do not fit the mechanism of the delayed negative coefficient. The models of feedback reactivity for Mark II and Mark III core loading are presented. For Mark II, the main point to be emphasized is the cause of time delay by heat transfer from the core to the structure. The delayed negative reactivity is treated by a transfer function that takes into account axial temperature distribution in the core. It is demonstrated that the delayed negative reactivity combined with the prompt positive reactivity is sufficient to permit the resonance instability. For Mark III, the frequency transfer functions of feedback reactivity were separated from the experiment. The model is compared with the result of measurements. (auth)

30283 FROM HINKLEY . . . TO SIZEWELL. *Nuclear Eng.*, 6: 364-70(Sept. 1961).

Comparisons of design and costs of the Hinkley and Sizewell power stations are presented. Since the Hinkley station is the older of the two (under construction), it is shown how

technology advanced from the mistakes made in the design features of this station. The most important contributions to the rather dramatic cost reduction (the estimate for the capital cost of Sizewell per kilowatt installed is some 30% less than the expected cost of Hinkley) are: an increase in the station output brought about partly by an increase in the coolant gas pressure, allowing a reduction in the number of primary loops from six to four; the combination of two reactors into one major building with a common charge floor; positioning of the circulators within the boilers, which allows a simple main duct layout; the use of two standard turbines instead of six; attention to design details; and know how. (N.W.R.)

30284 AN ECONOMIC FAST REACTOR. L. R. Blake (Dounreay Experimental Reactor Establishment, Risley, Lancs, Eng.). *Nuclear Eng.*, 6: 371-5(Sept. 1961).

A fast reactor can be built for a capital cost as low as \$240/kw installed, with standards of safety significantly better than any existing fast reactor and adequate for a large-scale power program. Tests with unalloyed uranium to nearly 5% burn-up under conditions appreciably worse than in a fast reactor suggest that 6% average burn-up can be achieved with uranium/plutonium metal fuel at a power density of about 50 to 100 w/g, with a maximum center temperature of 700°C and with coolant average outlet temperature of 450°C. These conditions of coolant temperature and power density are conservative with respect to current fast reactor practice, but the center temperature and the burn-up are very much higher. Assuming \$240/kw net, and 5.5% interest charges and 20 years reactor life, giving 8.3% capital charges, the electric power costs of the fast reactor with a 0.7 load factor are approximately 3.7 mil/kwh. (N.W.R.)

30285 ENRICO FERMI. *Nuclear Eng.*, 6: 377-82 (Sept. 1961).

The Enrico Fermi fast breeder reactor plant at Monroe, Michigan is the first to be constructed of this type for the production of power and for experimental study. The reactor will have an initial charge of uranium 10 wt % molybdenum alloy fuel elements. The reactor is cooled by three circuits in series. The coolant is liquid sodium. Vapor from the third circuit is passed to the turbines for the generation of power. A complete description is given of the installation. Descriptions are given of the core, the fuel handling equipment, the primary and secondary circuits, and the control and safety systems. Fuel element fabrication is also described. (N.W.R.)

30286 SIZEWELL NUCLEAR POWER STATION. 1. OPTIMIZATION OF THE DESIGN. H. S. Arms (English Electric Co., Ltd., Whetstone, Leics, Eng.). 2. CONTROL AND INSTRUMENTATION. D. Moore (English Electric Co., Ltd., Whetstone, Leics, Eng.). 3. CIVIL AND MECHANICAL DESIGN ASPECTS. J. D. McKean and N. O. E. Lakin (Taylor Woodrow Construction Ltd., Whetstone, Leics, Eng.). 4. GAS CIRCUITS AND BOILERS. T. B. Webb (Babcock & Wilcox Ltd., Whetstone, Leics, Eng.). 5. CONVENTIONAL PLANT DESIGN. C. Bottrell and J. Caldwell (English Electric Co., Ltd., Whetstone, Leics, Eng.). *Nuclear Power*, 6: No. 65, 61-81(Sept. 1961).

A detailed description is given of the 580 Mw(e) Sizewell Nuclear Power Station which is to be in operation in 1965 with full output capacity expected in 1966. A drawing of the power station, in color with plant parameters, is included. (N.W.R.)

30287 BREEDER REACTORS. Alvin M. Weinberg. *Sci. American*, 202: No. 1, 82-93(Jan. 1960).

The breeding cycles, characteristics, and economics of fast and thermal breeder reactors are described. The descriptions cover all known breeder types. Schematic diagrams are presented for the EBR-2, HRE-2, and the Enrico Fermi Fast Breeder Reactor. (N.W.R.)

30288 POWER REACTOR TECHNOLOGY. Technical Progress Review, Vol. 4, No. 3. Walter H. Zinn (General Nuclear Engineering Corp., Dunedin, Fla.). June 1961. 99p.

A review of reactor development is presented. Selected, recently published reports of interest are reviewed and various areas of reactor development are examined. Included are sections on reactor applications, reactor physics heat transfer and fluid flow, reactor dynamics, shielding, fuel cycles, materials, design of Yankee Reactor, nuclear superheat program, and sodium graphite reactors. (J.R.D.)

30289 HEAT EXCHANGE ARRANGEMENT FOR NUCLEAR POWER PLANT. Friedrich Flatt (to Escher Wyss A. G.). Canadian Patent 621,139. May 30, 1961.

Several heat exchange arrangements for nuclear power plants are described in which the steam is heated to an intermediate temperature at high pressure in the reactor and then is heated to a higher temperature outside the reactor by a second coolant or steam at a lower pressure. (D.L.C.)

Production Reactors

30290 IRRADIATION OF RADIOELEMENTS. Ph. Germond. Bull. inform. sci. et tech. (Paris), No. 51, 29-33 (May 1961). (In French)

Seven reactors are used in France for the production of radioisotopes. Two are heavy water reactors, two are swimming pool reactors, and three are graphite moderated reactors. The characteristics of these reactors are tabulated. The irradiation techniques and facilities at these reactors are briefly discussed. (J.S.R.)

Research Reactors

30291 (AHSB(S)R-23) RELIABILITY OF PROTECTIVE SYSTEMS FOR ZERO ENERGY REACTORS.

D. Wray and M. J. Cowper (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, Risley, Lancs, England). June 9, 1961. 15p.

The probability of failure of any protective system can be reduced to an acceptable level by the application of redundancy combined with a suitable periodicity of proof testing. The protective system can be subdivided into three parts: the instruments and sensors, the shut-down mechanisms, and the safety lines linking these two together. The probability of failure of each of the subsystems was estimated in terms of the equipment failure rate, the periodicity of proof testing, the protective logic adopted, and the frequency of the incidents. The effects of this probability of using two-parameter protection instead of one was evaluated. The limitations of the use of interlocks and design limitations to lower the incident rates are discussed. (auth)

30292 (ANL-6383) THE PHYSICS DESIGN OF THE EBR-II. W. B. Loewenstein (Argonne National Lab., Ill.). July 1961. Contract W-31-109-eng-38. 70p.

The physics design problems of the EBR-II are summarized. These include analysis of the EBR-II engineering design as well as applicable zero-power critical experiments. Pertinent reactor safety problems are reviewed. Safety considerations bearing on normal plant operation

and manipulations within the reactor are emphasized. The implication of controlled in-pile meltdown experiments is considered. Irradiation damage and metallurgical phase phenomena are summarized and related to reactivity. The nuclear performance of the system is considered in terms of actual plant operation. The predicted shift of both power and reactivity from core to radial reflector is described. (auth)

30293 (DP-567) THE HEAVY WATER SYSTEM OF THE PROCESS DEVELOPMENT PILE. Albert E. Dunklee (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). June 1961. Contract AT(07-2)-1. 68p.

Facilities for the control and handling of the 110-ton charge of heavy water in the Process Development Pile (PDP) at the Savannah River Laboratory are described. A description of the reactor is given. The problems encountered in the containment and preservation of heavy water in a large system are discussed with reference to the experience gained in seven years of operation of the PDP. General physical properties of heavy water are given. (auth)

30294 (GEAP-3398) DESIGN SUMMARY REPORT FOR THE GETR-HELIUM LOOP-1. R. F. Hausman (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). June 9, 1960. For Oak Ridge National Lab. Contract W-7405-eng-26, Subcontract 1350. 342p.

A description is given of the design, installation and subsequent modification of a He-cooled test loop which was installed in the General Electric Test Reactor. The facility is described and illustrations are included along with supporting information. A report of the safeguard analysis is also included and methods used to evaluate loop performance are described. (J.R.D.)

30295 (HPR-9) MEASUREMENTS ON SPIKE ELEMENTS IN RO AND HBWR. R. Persson and N. Standal (Norway. Institutt for Atomenergi. OEEC Halden Reactor Prosjekt). [nd]. 51p.

A description is given of mixed lattice experiments carried out in the Swedish zero power reactor (RO) and in the Halden Heavy Water Boiling Reactor (HBWR). Seven 1.5% enriched UO_2 cluster elements canned in stainless steel were used for the measurements. Experiments were carried out on three hexagonal lattices with 13, 16, and 19-cm pitch. Measured values of the buckling with one and two spike elements in different radial positions were fitted to an analytical expression. First order perturbation theory is sufficient to describe this dependence within the experimental uncertainties. Interaction effects between spike elements were evaluated. The interaction effect is strongly dependent upon the lattice pitch. For 19-cm pitch no interaction effect could be measured, whereas for 13-cm pitch it was relatively pronounced. The intracell flux distribution was measured for a lattice with 16-cm pitch, and agrees fairly well with a P_3 calculation dividing the cell into three regions. A two-group calculation of the macroscopic thermal flux distribution with seven spike elements as a central zone with 16-cm pitch compared well with the measured one. The introduction of the spike elements was found to have no measurable effect on the water level reactivity coefficient for all core configurations studied. The statistical weight method was used to evaluate the material buckling of the spike lattices. The experimental values agree fairly well with calculated ones. The maximum reactivity which can be obtained from the spike elements in HBWR is evaluated at $1.93 \pm 0.15\%$. The excess reactivity of the core without the spike element is 4.10%. (auth)

30296 (LA-612) FLUX MEASUREMENTS AT ISRAEL RESEARCH REACTOR 1. G. Davis (Ben-David) and B. Hübschmann (Israel. Atomic Energy Commission, Tel-Aviv). June 1961. 61p.

The neutron flux is measured in the core of the Israel Research Reactor-1, in order to estimate the power distribution and hence the relative burn-up of the fuel elements. The flux measurements involve measuring thermal and epithermal neutrons throughout the core. In addition, measurements of fast, epithermal and thermal neutrons are taken at experimental positions adjacent to the core, including the pneumatic rabbit, the six beam tubes, and the thermal column, to assist in the design of experiments. Gamma flux dose rates are also measured at selected positions, using the Fricke ferrous sulfate method. (auth)

30297 (IDO-16631) METHODS TO LOCATE SOURCES OF HIGH ACTIVITY IN THE MATERIALS TESTING REACTOR. John F. Sommers (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Dec. 5, 1960. Contract AT(10-1)-205. 27p.

The location and removal of sources of abnormal radioactivity in the MTR Process Water System are of primary importance for the safe and economic operation of the reactor. Methods developed and used to trace sources of abnormal activity are explained along with discussion and some examples of the use of these methods. Considerable detailed analysis of the practical problems that exist in using these procedures is also included. (auth)

30298 (NDA-2131-37) AMENDMENT I TO PAWLING LATTICE TEST RIG HAZARDS SUMMARY REPORT (NDA-2109-3). R. Schamberger, G. Foster, and W. Brooks (Nuclear Development Corp. of America, White Plains, N. Y.). May 15, 1961. Contract AT(30-1)-2303. 39p.

Experimental data for the reactivity worth of various PLATR components are available. Measured values of the reactor parameters formerly computed or estimated are given; values measured in PRR which have remained unchanged are included to give a complete picture. The most serious nuclear incident which is considered credible is a filling accident following a lapse in loading procedures which results in an excess reactivity of a few dollars with the D_2O at normal height. The accident also requires the failure of the period scram, inattention or incompetence of the operator, failure of the safety rod system, and failure of the dump system. (auth)

30299 (NP-10702) PROGRESS REPORT [ON REACTOR OPERATION] FOR PERIOD ENDING DECEMBER 1960. (Aktiebolaget Atomenergi, Stockholm). 1961. 9p. (R-29).

Summaries are discussed for work performed in buckling measurements carried out in R-0 reactor, and developments and operations for R-1, R-2, and R-2-0 reactors, and the loop program. (B.O.G.)

30300 THE MATERIALS TESTING REACTOR NEEDED BY JAPAN. Tadao Suzuki. Genshiryoku Kōgyō, 6: No. 3, 7-12(Mar. 1960). (In Japanese)

In a recent survey of the Japanese atomic energy industry, the Atomic Energy Research Institute, and the steel industry, it was attempted to ascertain the type of the materials testing reactor needed by Japan. Information was requested on the type of tests to be performed, the sizes and the number of the experimental beam holes, the desired neutron flux level and the duration of the proposed irradiation tests. On the basis of the answers received the following design characteristics have been developed: use of light water as moderator, operation cycle of one month, thermal neutron flux in the core of $1 \cdot 10^{14}$ n/cm²sec, fast neutron flux of $1 \cdot 10^{15}$ n/cm²sec, and thermal power output of 125 Mw. Three different diameter holes are proposed including one 225-mm hole, four or five 150-mm and two or three 75-mm holes. The reactor installation will be provided with the needed hot cells and auxiliary facilities. The construction cost is estimated at 60 to 80 $\cdot 10^8$ yen (about \$16 million) and the yearly maintenance at 15 to 20 $\cdot 10^8$ yen (about \$4 million). The survey established the feasibility of constructing such a reactor with Japanese national resources only. The reactor could be in actual operation soon after 1965. (TTT)

30301 TRANSISTOR COUNTING-RATE CHANNEL FOR TRIGA REACTORS. John H. Cawley (General Dynamics Corp., San Diego, Calif.). Nucleonics, 19: No. 9, 82-6 (Sept. 1961).

Methods of bringing Triga reactors from the source range [~ 10 to 15 cps, 10 mw(th)] up to intermediate power levels are presented. A counting rate device for accomplishing this end is discussed; Triga operators rely on a compact channel that responds with ~ 0.25 μ sec rise time to 200 μ v pulses from a fission chamber. (L.N.N.)

WASTE DISPOSAL AND PROCESSING

30302 (CF-61-9-31) CESIUM EXCHANGE BY VERMICULITE. D. G. Jacobs (Oak Ridge National Lab., Tenn.). Sept. 12, 1961. Contract W-7405-Eng-26. 13p.

The cesium-exchange properties of various grades of commercially available vermiculite were investigated. Elucidation of the reaction mechanism led to improvement of the cesium-sorptive properties, either by treatment of the vermiculite or by addition of potassium salts to the waste stream. Studies of the kinetics and thermodynamics of the exchange reaction permitted extrapolation of the data for consideration of the extended use of vermiculite columns for decontaminating other waste streams. (auth)

30303 (HW-65806(Pt.I)) RADIANT-HEAT SPRAY-CALCINATION PROCESS FOR THE SOLID FIXATION OF RADIOACTIVE WASTE. PART I. NONRADIOACTIVE PILOT UNIT. R. T. Allemann and B. M. Johnson, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 1961. Contract AT(45-1)-1350. 95p.

The spray calcination of simulated wastes was studied in a relatively small scale reactor 8 in. in diameter and 10 ft tall. A wide variety of compositions were handled without difficulty, including wastes generated by TBP-25, Darex, and Zircflex processes as well as many possible compositions of acidic and neutralized, high-level Purex wastes. The product characteristics, such as particle size and density, varied somewhat with the feed composition. The powder, made up of flakes of exploded droplets, was generally rather fine, and as much as 95% could pass through 325-mesh screen. Density of the powder ranged from 0.12 g/cc for aluminum nitrate-type waste to 1.2 g/cc for Purex waste adjusted in composition by the addition of sugar and phosphoric acid. Considerable attention has been given to the use of additives to increase the bulk density of the powder product, to form a powder which subsequently can be melted into a consolidated solid for final storage, and to promote more complete calcination of the powder during its short residence time in the reactor. When phosphoric acid was added to simulated Purex acidic waste, the resultant product melted at 800 to 900°C. The properties of calcined powder also were altered; bulk density was increased roughly from 0.5 to 0.85 g/cc; and the surface area average particle size was more than doubled. The addition of other anions, such as sulfate and borate, was studied. Boric acid or sodium tetraborate may be added to wastes containing considerable aluminum to produce true glass matrices on calcination and fusion. The bulk density of calcined powder from an aluminum nitrate-type waste was increased from 0.12 to 0.7 g/cc by the addition of sodium tetraborate. Sugar is a useful additive for a number of reasons. First used to promote melting of particles of phosphate-treated feed during their residence in the reactor, it was also used to decompose sodium nitrate and unstable ferric and aluminum sulfates, and to neutralize excess sodium hydroxide in more feed compositions. Thermal conductivity of the powder product was low, ranging from 0.05 to 0.135 Btu/(hr)(ft²)(°F/ft) over temperatures of 100 to 400°F, and was primarily dependent on density rather than composition. Melting and consolidating the product greatly increased the conductivity, to the vicinity of 0.6 Btu/(hr)(ft²)(°F/ft) for borate-type glasses, for example. The extent of calcination was not greatly affected by the feed rate up to 4 gph. It generally decreased slightly except with feeds

adjusted by the addition of sugar. Calcination increased at higher feed rates. Short-duration corrosion tests of the spray calciner with typical Purex calcination conditions indicated good resistance for two possible construction materials—Inconel and AISI 446 SS. Porous metal filters were used most successfully for separation of the powder and gas, but corrosion may limit their applicability and necessitate the use of ceramic elements. Cyclones were not very successful in the small unit but may be applicable on a larger scale. With porous metal filters, de-entrainment factors of 10^4 and 10^8 from the feed to the condensate and the off-gases, respectively, were measured. Ruthenium and cesium volatilization was less than 2% with both acidic and basic feed liquors, as measured by including in the feed augmented quantities of inactive isotopes of each element. The temperature profile of a radial cross section of the reactor (below a 2-ft nozzle zone) was absolutely flat within limits of measurement. This fact, and measurements of the degree of turbulence within the reactor, indicated that scaleup of the unit to a 2½-ft-diameter unit, for example, probably is feasible without a marked decrease in volumetric capacity. (auth)

30304 (IDO-14504) RESEARCH AND DEVELOPMENT STUDIES ON WASTE STORAGE PROCESS. M. H. Ortner, C. J. Anderson, and P. F. Campbell (Vitro Labs., West Orange, N. J.). May 19, 1961. For Phillips Petroleum Co., Contract AT(10-1)-205, Subcontract C-215. 132p.

The basic objectives of this program were the determination of the thermal stability of various fission product oxides and nitrates, and an investigation of the gas phase decomposition of ruthenium tetroxide. To accomplish these objectives, a literature survey was first made of available physical and chemical data for the oxides and nitrates of Cs, Sr, Ru, Zr, Nb, and Ce. The data were supplemented by a calculation of thermodynamic functions for RuO₄ vapor from the experimentally determined infrared spectrum and the theoretically calculated raman-active fundamentals. Data are presented graphically. (C.H.)

30305 (NAA-SR-Memo-4620) HNPf LIQUID WASTE DISPOSAL COST STUDY. A. R. Piccot (Atomic International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 6, 1959. 33p.

The HNPf cost analysis for waste disposal was made on the basis of 10,000 gallons of laundry waste and 9,000 gallons of other plant waste per year. The costs are compared for storage at HNPf site for 10 yr, packaging and shipment to AEC burial ground, packaging and shipment for sea disposal, and disposal by licensed vendor. A graphical comparison is given for the yearly costs of disposal by licensed vendor and the evaporator system as a function of waste volume. Recommendations are included for the handling of the wastes expected from HNPf operations. (B.O.G.)

30306 (NYO-9652) STUDIES ON DECAY-HEAT REMOVAL BY AIR CONVECTION FROM STORED CERAMIC MEDIA CONTAINING HIGH LEVEL FISSION PRODUCT WASTES. Period covered: September 1960–June 1961. B. C. Kim, N. E. Stefany, P. H. Fricke, and R. Eliassen (Massachusetts Inst. of Tech., Cambridge. Sedgwick Labs. of Sanitary Science). July 24, 1961. Contract AT(30-1)-621. 39p.

The storage of glass cylinders containing high-level radioactive wastes from nuclear fuel reprocessing plants

presents a problem of cooling. The continuous generation of heat from decaying radioisotopes in the stored fission products must be countered by a cooling medium. Free convection cooling with air offers a possible safe and economical solution. The design of a satisfactory storage system depends on a knowledge of the controlling parameters of heat transfer and convection. Free convection laminar flow and heat transfer of air in a vertical channel with linearly varying wall temperatures were studied analytically and experimentally. With a uniform heat flux at the wall, the vertical wall temperature was found to vary linearly except for the inlet and outlet regions where end effects may be appreciable. In the analysis of velocity and temperature distribution, the Rayleigh number was found to be a significant parameter. From the temperature distribution function a heat transfer correlation was established by expressing a Nusselt number as a unique function of the Rayleigh number. Over the range of values for the Rayleigh number from 100 to 36,000 and for the Nusselt number from 3.3 to 15.3, the heat transfer correlation was found to be valid within experimental errors. The heat flux at the wall increased with increasing channel width but became independent of the channel width when the Rayleigh number exceeded 2,500. An approximate design procedure was indicated for storage and cooling of slabs of glass containing radioactive wastes by calculating estimated values of design parameters. (auth)

30307 (ORNL-3053) STATUS REPORT ON WASTE DISPOSAL IN NATURAL SALT FORMATIONS: [PART] III. W. J. Boegly, Jr., R. L. Bradshaw, H. Kubota, F. L. Parker, and E. G. Struensee—F. M. Empson, ed. (Oak Ridge National Lab., Tenn.). Sept. 11, 1961. Contract W-7405-eng-26. 101p.

Variables studied include the reactions of salt-saturated Purex wastes, both cold and in the presence of gamma radiation fields, the stability of cavities excavated in the salt structure when influenced by heat, and thermal studies aimed at determining the rate of heat flow both experimentally and through computations. Heat transfer rates measured in the field experiments agree very well with computations on which the experiments were based. It was found that the production of nitrosyl chloride (NOCl), hydrogen chloride, and nitrogen oxides produced by chemical action in salt-saturated, acid Purex waste could be controlled by maintaining acid strength below 4.0 M and/or temperature below 60°C. There was no significant difference in gaseous reaction products from experiments in pure salt and in a part of the structure containing significant quantities of anhydrite. Laboratory studies of radiolytic gas production in the salt-acid Purex waste system indicate that the gas production can be controlled by suspending the waste solutions as surface films on crushed salt or by fixing them as absorbed water in the lattices of certain minerals. Further analytical studies of the thermal problems associated with disposal of wastes in salt show that a cooling period of at least 3 years before ultimate disposal is desirable because of the rapid decrease of maximum temperatures with increased cooling times out to about 1000 days. (N.W.R.)

30308 (ORNL-3105) REDUCTION OF LIQUID RADIOACTIVE WASTES TO SOLIDS: SCOUTING TESTS. C. W. Hancher (Oak Ridge National Lab., Tenn.). Nov. 24, 1958. Contract W-7405-eng-26. 15p.

Scouting experiments indicated that calcination of highly active Darex and Sulfex decladding and Purex extraction wastes will not release hazardous amounts of fission products to the atmosphere. Simulated wastes containing

up to 90 curies/liter of activity were evaporated and calcined to 750°C and the off-gases passed through a condenser and a series of caustic scrubbers. Less than 0.1% of the fission products was released, of which ruthenium was 10 to 90%. Fission product release was lower from neutralized than from acidic wastes. Fission products were leached appreciably, 0.05% of the beta and 0.02% of the gamma, from the calcination solid with water in 96 hr. (auth)

30309 (TID-5718) REACTOR FUEL WASTE DISPOSAL PROJECT PRESSURE-TEMPERATURE EFFECT ON SALT CAVITIES AND SURVEY OF LIQUEFIED PETROLEUM GAS STORAGE. K. E. Brown, F. W. Jessen, and E. F. Gloyne (Texas. Univ., Austin, Sanitary Engineering Labs.). Jan. 15, 1959. Contract AT(11-1)-490. 114p.

It is deemed feasible to store reactor fuel wastes in a salt dome cavity to a depth where the differential in pressure between the soil over-burden pressure and pressure of the fluid inside the cavity does not exceed 3000 psi, and the temperature is less than 400°F. Tests at pressure increments of 1000 psi were conducted on a 2" cylindrical cavity contained in a 6-in. long by 6-in. cylindrical salt core. Tests indicate that the cavity exhibited complete stability under pressures to 3000 psi and temperatures to 300°F. At temperatures of 100 to 400°F and pressures to 5000 psi continuous deformation of the cavity resulted. Initial movement of the salt was observed at all pressures. This was evidenced by vertical deformation and cavity size reduction. It was noted that a point of structural equilibrium was reached at lower temperatures when the pressure did not exceed 5000 psi. A literature study reveals that the most common type of cavity utilized in liquefied petroleum gas storage is either cylindrical or ellipsoidal. A few are pear or inverted cone shaped. There was no indication of leakage for cavities when pressure tested for as long as 72 hr. This indicates that the salt mass is not permeable under conditions of prevailing underground temperature and pressure. Salt specimens tested under atmospheric pressure and temperature exhibited permeabilities of 0.1 to 0.2 millidarcys. The cost of completing underground storage cavities in salt masses is expected to be approximately \$1.05 per barrel of storage space. (auth)

30310 (TID-7621) GROUND DISPOSAL OF RADIOACTIVE WASTES, CONFERENCE PROCEEDINGS, BERKELEY, CALIFORNIA, AUGUST 25-27, 1959. Warren J. Kaufman, comp. and ed. (California. Univ., Berkeley. Sanitary Engineering Research Lab. and California. Univ., Berkeley). July 1961. Contract AT(11-1)-34. 172p.

A total of 19 papers are included for 17 of which separate abstracts were prepared. Two papers were previously abstracted for NSA one of which concerns ground water flow at Hanford, and the other concerns movement of liquid through soils. (J.R.D.)

30311 (TID-7621) INTRODUCTION TO THE HANFORD TOPICS. D. W. Pearce (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

An introduction to Hanford topics to be discussed at the conference is presented in which a geophysical description of the area is given followed by discussion of Hanford waste philosophy and a brief review of radioactive waste standards. (J.R.D.)

30312 (TID-7621(p.7-16)) OPERATING PRACTICES AND EXPERIENCES AT HANFORD. C. E. Linderth and

D. W. Pearce (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A review of practices and experience at Hanford is presented which includes data on waste volume, radioactivity information, and discussion of waste management. Figures showing disposal facilities and distribution of waste in the disposal areas are included. (J.R.D.)

30313 (TID-7621(p.17-33)) OPERATING PRACTICES, EXPERIENCES, AND PROBLEMS AT THE NATIONAL REACTOR TESTING STATION. Bruce L. Schmalz.

A review of practices, experience, and problems at NRTS is presented which includes information on the geology of the area, general operating practices, liquid waste disposal, and the monitoring program. The effectiveness of fluorescein dye as a tracer in basalt at NRTS was established. Plans for additional monitoring wells are outlined, and the requirements for these and other wells are substantiated. (J.R.D.)

30314 (TID-7621(p.34-6)) DISPOSAL PRACTICES AND EXPERIENCE AT THE SAVANNAH RIVER PLANT. J. Henry Horton (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.).

A review of disposal practices and experience at the Savannah River Plant is presented which includes information on geology of the area and a discussion of ground-water monitoring. It is noted that monitoring wells should be considered earth probes from which it is possible to obtain data on the radioactivity present in the ground water and in the formation material. Tritium was successfully used as a seepage tracer. (J.R.D.)

30315 (TID-7621(p.37-9)) WASTE DISPOSAL OPERATIONS AT MOL, BELGIUM. Paul Dejonghe (Brussels. Centre d'Etude de l'Energie Nucléaire).

A review of waste disposal operations at Mol is presented which includes information on geology of the area, population density influences on waste disposal philosophy, and physicochemical ground studies. (J.R.D.)

30316 (TID-7621(p.40-8)) WASTE DISPOSAL OPERATIONS AT THE CHALK RIVER PROJECT OF ATOMIC ENERGY OF CANADA LIMITED. I. L. Ophel (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.).

A review of waste disposal at Chalk River is presented which includes information on liquid and solid disposal, surface and underground radionuclide movement, and a general discussion on the subject. (J.R.D.)

30317 (TID-7621(p.51-3)) THE FUNDAMENTALS OF ION EXCHANGE EQUILIBRIA. Henry C. Thomas (North Carolina. Univ., Chapel Hill).

A summary is presented of a thermodynamic treatment of the sorption process in soil. The study indicates how the results may be expressed in terms of mixing entropies and enthalpies of exchange. It is suggested that such treatment may be developed for use in predicting sorption processes not tried in the laboratory. (J.R.D.)

30318 (TID-7621(p.54-68)) SORPTION AND RETENTION BY CLAY MINERALS: OAK RIDGE STUDIES. T. Tamura, F. S. Brinkley, B. L. Houser, D. G. Jacobs, and O. M. Sealand (Oak Ridge National Lab., Tenn.).

Methods of using clays for containment of fission products are examined. By heating mixtures of waste and clay that contain appropriate fluxes, fission products can be fixed in the resultant durable and insoluble matrix. Another method is by contacting the waste solution with the clay material, after which the fission products can be

sorbed from solution, immobilizing the cationic fission products and lessening the probability of environmental contamination. Data and discussion related to these processes are included. (J.R.D.)

30319 (TID-7621(p.69)) COMMENTS ON WASTE DISPOSAL TO THE EARTH AT THE OAK RIDGE NATIONAL LABORATORY. Donald Jacobs and Wallace De Laguna (Oak Ridge National Lab., Tenn.).

A discussion of ground disposal at ORNL is presented. Limitations imposed by geology and topography are noted and it is pointed out that exchange-adsorption treatment will probably continue to be necessary for handling intermediate-level wastes. Other discussion centered around the fact that the disposal pits are uncovered. (J.R.D.)

30320 (TID-7621(p.70-82)) RECENT STUDIES AT HANFORD ON SOIL AND MINERAL REACTIONS IN WASTE DISPOSAL. J. L. Nelson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A brief review of early Hanford work on equilibrium aspects of soil waste disposal is presented followed by a closer examination of recent laboratory soil studies. In the last two years, soil column and equilibrium studies were conducted to study all known variables involved in the reactions of fission products, especially Sr, with soils. A study of the effects of unsaturation on ion exchange, spreading, and tests with model cribs are also parts of the overall program. Discussions of Sr removal by reactions with calcite and Cs removal by reaction with Zeolites are also included along with graphically presented data. (J.R.D.)

30321 (TID-7621(p.83-9)) ION EXCHANGE AND ADSORPTION ON LIGNEOUS MATERIAL. P. Dejonghe and L. Baetsle (Brussels. Centre d'Etude de l'Energie Nucléaire).

The possibility of using lignite as a natural ion exchanger in a combined chemical and physicochemical treatment scheme for the handling of radioactive effluents was examined. Approaches to the problem include establishment by empirical means of the general character of this exchanger and its potential value in a low-cost treatment system, and establishment of the optimum conditions for applying lignite by a basic study of its ion exchange equilibrium and kinetic properties. (auth)

30322 (TID-7621(p.90-9)) PRELIMINARY INVESTIGATIONS OF THE ADSORPTION OF RADIOSTRONTIUM IN SACLAY SOIL. THREE-COMPONENT SYSTEM. P. Cohen and C. Gailledreau.

A summary of measurements of the Sr^{90} partition coefficients in Saclay soil is presented. Information from a preliminary study on adsorption of trace ions from solutions containing two bulk ions is also included. (J.R.D.)

30323 (TID-7621(p.101-16)) ION EXCHANGE PROPERTIES OF A REPRESENTATIVE OIL SAND. Ben B. Ewing and James V. Kerrigan (California. Univ., Berkeley. Sanitary Engineering Research Lab.).

Laboratory studies are reported on radiocesium exchange with Meyer oil sand and with the reference American Petroleum Institute clay, kaolinite. Meyer sand studies include those concerned with the effects of column length on Cs^{137} breakthrough and the effects of Ca ion concentrations on the equilibrium of the medium for trace Cs concentrations. Parallel studies were carried out with kaolinite in which the effects of Ca and H ions on Cs exchange were investigated. (J.R.D.)

30324 (TID-7621(p.117-19)) ION EXCHANGE RESEARCH BY THE U. S. GEOLOGICAL SURVEY. C. R. Naeser.

Studies of radioactive wastes are described in which natural materials are used to remove Cs^{137} and Sr^{90} . Fundamental studies on the nature of clay minerals are also discussed. Vermiculite was studied as a possible Cs^{137} scavenger, and crandallite ($\text{CaAl}_3(\text{PO}_4)_2 \cdot \text{H}_2\text{O}$) was studied as a potential Sr^{90} scavenger. Clay studies were devoted to determining if various kinds of exchange sites exist in these materials, and their differences if they do exist. (J.R.D.)

30325 (TID-7621(p.123-30)) DISPERSION IN FLOW THROUGH POROUS MEDIA. G. de Josselin de Jong (California. Univ., Berkeley).

A discussion of the causes of dispersion is presented. The aspect of dispersion examined is exemplified by the case in which a fluid in a porous medium is displaced by another fluid and the interface between the two fluids becomes diffuse. The macrostructural and microstructural causes of dispersion are discussed along with the effects of molecular diffusion. (J.R.D.)

30326 (TID-7621(p.131-9)) DISPERSION RELATIONS IN INJECTION DISPOSAL OF RADIOACTIVE WASTES. Yoriteru Inoue and Warren J. Kaufman (California. Univ., Berkeley. Sanitary Engineering Research Lab.).

An analysis is presented of underground movement of radioisotopes comprising a radioactive waste. Injection geometries chosen for consideration include one-dimensional flow systems, as typified by columns, radial flow systems, and two well systems in which one well serves for injection of the waste and the second serves to remove the treated waste from the formation. (J.R.D.)

30327 (TID-7621(p.157-66)) UNDERGROUND WASTE DISPOSAL STUDIES; CHEMICAL PROCESSING PLANT AREA. Alan E. Peckham (Geological Survey, Idaho Falls, Idaho).

Information collected in studies of saline liquid waste movement in the disposal area at NRTS is presented. Data are discussed and it is concluded that the solutions are moving down the regional slope defined by the generalized regional water level contours. Data indicate that the saline water is moving with the normal water in the area in one or more horizons to form a band that widens an unidentified amount down-gradient. Data also indicate straight-line average rates of ground-water movement of 15 to 50 ft per day. (J.R.D.)

30328 (TID-13426) RESEARCH AND DEVELOPMENT STUDIES ON WASTE STORAGE PROCESS. Final Report, July 8, 1958-June 30, 1959. Vitro Job 2138. M. H. Orther, C. J. Anderson, and P. F. Campbell (Vitro Labs., West Orange, N. J.). Aug. 31, 1959. For Phillips Petroleum Co., Contract AT(10-1)-205, Subcontract C-215. 128p.

Fundamental information on the physical and chemical properties of the fission product oxides and nitrates of cesium, cerium, niobium, ruthenium, strontium, and zirconium, the thermal stability of these fission products up to 1500°C , and the vapor phase decomposition of ruthenium tetroxide is given. The information is obtained by a literature survey and the determination of the thermal stability of the fission product oxides and nitrates. These data are also supplemented by a calculation of thermodynamic functions for RuO_4 vapor from the experimentally determined infrared spectrum and the theoretically calculated Raman-active fundamentals. (N.W.R.)

30329 THE TREATMENT OF RADIOACTIVE WASTES AT MOL. P. Dejonghe (Société Belge de Chimie Nucléaire, [Brussels]). Bull. inform. assoc. belge develop. pacifique énergie atomique, No. 32, 5-7, 9-11 (May 1961). (In French)

The waste processing center at Mol decontaminates wastes from different laboratories using a continuous process. The installation has a capacity of $15 \text{ m}^3/\text{hr}$ for a waste having an activity of $10^{-2} \mu\text{C}/\text{cm}^3$ and consists of the following parts: two pretreatment reservoirs, two groups of mixers and decanter-floculators mounted in series, an ion-exchange installation, and two post-treatment reservoirs provided with mixers and a draining system. The problems of drying and making the wastes insoluble and then the final storage of the solid wastes are reviewed. The factors affecting storage in the ground are discussed. Investigations on mineral ion exchangers are briefly indicated. (J.S.R.)

30330 PROCESS FOR THE DESTRUCTION OF THE RADIOACTIVE RESIDUES. Louis Verschraegen. Canadian Patent 620,485. May 23, 1961.

A process is outlined for treating radioactive wastes by exposing them to a flux of radiations or nuclear particles to transform the radioisotopes into stable isotopes or short-lived radioisotopes. Pb^{205} , Be^{10} , Sr^{85} , Bi^{207} , Tl^{204} , N^{13} , Pb^{202} , and Sr^{90} may be treated in this way; the case of Sr^{90} is discussed in detail. (D.L.C.)

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